UNCLASSIFIED

AD NUMBER
AD849017
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies only; Test and Evaluation; JAN 1969. Other requests shall be referred to Air Force Flight Dynamics Laboratory, ATTN: FDD, Wright-Patterson AFB, OH 45433.**
AUTHORITY
AFFDL ltr dtd 29 Oct 1973

THIS PAGE IS UNCLASSIFIED

AD0849017

AFFDL-TR-68-43
PART II

RANDOM-VIBRATION ANALYSIS SYSTEM FOR COMPLEX STRUCTURES

PART II. COMPUTER PROGRAM DESCRIPTION

K. TSURUSAKI
F. S. WALLACE
The Boeing Company

20080815 152

TECHNICAL REPORT AFFDL-TR-68-43, PART II

JANUARY 1969

Approved for public release; distribution unlimited

~~Distribution limited to U. S. Government agencies only; test and evaluation; statement applied December 1971. Other requests for this document must be referred to AF Flight Dynamics Laboratory, (FY), Wright-Patterson AFB, Ohio 45433.~~

AIR FORCE FLIGHT DYNAMICS LABORATORY
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

~~This document is subject to special export controls, and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Air Force Flight Dynamics Laboratory (FDDA), Wright-Patterson AFB, Ohio 45433.~~

Approved for public release; distribution unlimited.

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

100 - March 1969 - CO455- 67-1499

AFFDL-TR-68-43
PART II

AD849017

RANDOM-VIBRATION ANALYSIS SYSTEM FOR COMPLEX STRUCTURES

PART II. COMPUTER PROGRAM DESCRIPTION

K. TSURUSAKI
F. S. WALLACE

Approved for public release; distribution unlimited

~~This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Air Force Flight Dynamics Laboratory (FDDA), Wright-Patterson AFB, Ohio 45433.~~

~~Distribution limited to U. S. Government agencies only; test and evaluation; statement applied December 1971. Other requests for this document must be referred to AF Flight Dynamics Laboratory, (FY), Wright-Patterson AFB, Ohio 45433.~~

FOREWORD

The computer program reported herein was prepared by The Boeing Company for the Aero-Acoustics Branch, Vehicle Dynamics Division, Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio, under contract AF 33(615)-5155. The study demonstrates the application of finite-element matrix methods in determining the responses and fatigue life of complex panels excited by random pressure fluctuations. The program is part of a continuing effort to establish tolerance levels and design criteria for sonic fatigue prevention under the exploratory development program of the Air Force Systems Command. The effort was conducted under project 1471 "Aero-Acoustic Problems," task 147101 "Sonic Fatigue." Mr. D. L. Smith and Mr. M. C. Eifert of the Aero-Acoustics Branch were the task engineers.

The period covered by this effort is July 1966 through June 1968. This report is AFFDL-TR-68-43 "Random-Vibration Analysis System for Complex Structures," Part II "Computer Program Description" and is one of four documents prepared under contract AF 33(615)-5155. One document is Part I of this report entitled, "Engineering User's Guide." The other reports are AFFDL-TR-67-81, "A Finite-Element Analysis of Simple Panel Response to Turbulent Boundary Layers," and AFFDL-TR-68-44 "Finite-Element Analysis of Complex Panel Response to Random Loads." The Boeing Company's document number for this report is D6-23145 Part II.

The research was conducted by Loyd D. Jacobs and Dr. Dennis R. Lagerquist of the Structural Dynamics Staff of The Boeing Company's Commercial Airplane Division in Renton, Washington. The principal programming effort was conducted by Frank S. Wallace and Kiyoharu Tsurusaki of The Boeing Company's computing department.

Many other Boeing personnel contributed significantly to the project by providing major modifications to existing computer programs. They are R. D. Palm for extensive modifications to the matrix structural generation program, H. B. Noonchester for major modification and improvement in the eigenvalue/eigenvector program, and L. Anderson for modifications to the matrix manipulation module.

This report was submitted by the authors in July 1968.

This report has been reviewed and is approved.

Walter J Mykytow
WALTER J. MYKYTOW
Asst. for Research & Technology
Vehicle Dynamics Division
AF Flight Dynamics Laboratory

ABSTRACT

A programming description is presented for a computer program developed to aid in the design of sonic-fatigue-resistant aircraft structures. The computer program is written in FORTRAN IV and MAP for the IBM 7094 Mod II. The program employs matrix structural analysis methods to calculate statistical measurements of response (deflection and stress) for complex structure subjected to pressure loads random in both time and space. The program is organized into two phases, each performed separately. The phases are further organized in modular form for ease of maintenance and/or modification.

CONTENTS

Section | Page

I INTRODUCTION 1

II GENERAL PROGRAM DESCRIPTION 3

1. Program Organization 3
   a. Phase I—Structural and Vibration Programs 3
   b. Phase II—Random Load and Response Programs . . . 3
2. System Organization 6
   a. Phase I and II Overlay Structures 6
   b. Core and Tape Requirements 6
   c. Deck and Master Tape Setups 6

III PHASE I—STRUCTURAL AND VIBRATION PROGRAMS 21

1. Matrix Structural Generator Program (MAST) 21
   a. General Description 21
   b. Major Program Functions 22
   c. Programming Organization 35
   d. MAST Subroutine Listing 35
2. Intermediate Matrix Merge 48
   a. Subroutine AMERGE 48
   b. Subroutine SMERGE 49
3. Vibration Program (FREMOD) 49
   a. General Description 49
   b. Programming Organization 58
   c. FREMOD Subroutine List 67

IV PHASE II—RANDOM LOAD AND RESPONSE PROGRAMS 69

1. Random Loading Module (RANLOD) 69
   a. General Description 69
   b. Programming Organization 73
2. Random-Response Solution Programs (RANSO) 83
   a. General Description 83
   b. Option 1 Solution Program—General Viscous Damping 97

CONTENTS (Concluded)

Section Page

c. Option 2 Solution Program—Normal Modes 110

d. Option 3 Solution Program—Normal Modes Without Cross Terms 136

APPENDIX I TL01 DESCRIPTION AND LISTING 151

APPENDIX II SUBROUTINES READTP, WRTETP, FVIO, FILE, INRPRD, AND FRUN 239

APPENDIX III PHASE I PROGRAM LISTING. 259

APPENDIX IV PHASE II PROGRAM LISTING 405

ILLUSTRATIONS

Figure	Title	Page
1	Phase I Organization	4
2	Phase II Organization	5
3	Phase I and II Overlay Structures	7
4	Phase I Master Tape	18
5	Phase II Master Tape	18
6	Elemental Beam Stiffness Matrix Layout	23
7	Elemental Beam Stress Matrix Layout	24
8	Quadrilateral Plate Layout	25
9	Elemental Plate Stress Matrix Layout	26
10	Elemental Plate Stiffness Matrix Layout	27
11	Structural Matrix Partitioning	28
12	Merged Stress Matrix	28
13	Stiffness Matrix Partitions	30
14	Sorted Stress Matrix Partition	31
15	Sorted Stiffness Matrices	33
16	TL01 Phase Layout	34
17	MAST Overlay Structure	36
18	MAST Flow Chart	37
19	MAST Subroutine Tape Use Chart	43
20	Phase I Master Tape Detail	45
21	AMERGE Flow Chart	50
22	SMERGE Flow Chart	52
23	FREMOD Macro Flow Chart	54
24	FREMOD Program Organization	55
25	VALVCT Flow Chart	64
26	HESSEN Flow Chart	65
27	QRITER Flow Chart	65
28	SORTRT Flow Chart	65
29	VECTOR Flow Chart	66
30	TRANS1 Flow Chart	66
31	TRANS2 Flow Chart	66

ILLUSTRATIONS (Continued)

Figure	Title	Page
32	FREMOD Overlay Map	67
33	RANLOD Placement	70
34	RANLOD Input/Output Diagram	70
35	RANLOD Subroutine Flow	72
36	RANLOD Flow Chart	74
37	ARIA Flow Chart	76
38	CONST Flow Chart	76
39	NOISOR Flow Chart	78
40	Separation-Algorithm Flow Chart	79
41	OUTPUT Flow Chart	81
42	Binary Output Tape Maps From RANLOD	82
43	RANSO Flow Diagrams	86
44	PEDAN Flow Chart	100
45	CONS Flow Chart	101
46	DSECM1 Flow Chart	102
47	COMINV Flow Chart	103
48	SRESP1 Flow Chart	104
49	TRAPM Flow Chart	105
50	SJNT1 Flow Chart	106
51	SSECM Flow Chart	107
52	CPSD1 Flow Chart	108
53	ADMIN2 Flow Chart	115
54	SCALE Flow Chart	117
55	CQJD Flow Chart	119
56	SUMT Flow Chart	121
57	SUM2 Flow Chart	123
58	SECM3 Flow Chart	125
59	ADMIT2 Flow Chart	127
60	CQCPSD Flow Chart	128
61	SUM3 Flow Chart	129
62	DJNT2 Flow Chart	130

ILLUSTRATIONS (Concluded)

Figure	Title	Page
63	SJNT2 Flow Chart	131
64	DSECM2 Flow Chart	132
65	SSECM2 Flow Chart	133
66	CPSD2 Flow Chart	134
67	SRESP2 Flow Chart	135
68	ADMIN3 Flow Chart	139
69	ADDMAT Flow Chart	141
70	DSECM3 Flow Chart	143
71	ADMIT3 Flow Chart	145
72	DJNT3 Flow Chart	146
73	SJNT3 Flow Chart	147
74	DSJNT3 Flow Chart	148
75	CPSD3 Flow Chart	149
76	SRESP3 Flow Chart	150
77	TL01 Flow Chart	152

NOMENCLATURE

$[C]$	damping matrix
$[C_F(\omega)]$	force co-PSD matrix ($\mathrm{lb}^2 \cdot \mathrm{sec}$)
$[F]$	flexibility matrix
r	eigenvalue
$[F_r]$	reduced flexibility matrix
F_x, F_y, F_z	forces in the x , y , and z directions, respectively (lb)
g	structural damping coefficient
$[H(i\omega)]$	admittance matrix
i	$\sqrt{-1}$
$[K]$	stiffness matrix
$[K_{cc}]$	partition of stiffness matrix corresponding to constrained freedoms
$[K_{fc}]$, $[K_{cf}]$	partition of stiffness matrix relating free and constrained nodes
$[K_{ff}]$	partition of stiffness matrix corresponding to unrestrained freedoms
$[K_r]$	reduced-stiffness matrix
$[K_{11}]$, $[K_{12}]$, $[K_{21}]$, $[K_{22}]$	partitions of stiffness matrix
K	number of modal cross products in analysis
$[M]$	mass matrix
$\{M_j\}$	generalized mass
M_{xy}	plate-element twisting moment

M_x, M_y, M_z	bending moments about x , y , and z axes, respectively (in.-lb)
m	number of normal modes
N	number of kinematic degrees of freedom
$[Q_F(\omega)]$	force quad-PSD matrix ($lb^2 \cdot sec$)
$[S]$	matrix of stress-deflection relationships
$[S_1]$, $[S_2]$	partitions of stress matrix
$[\overline{\delta_q \delta_r}]$	deflection covariance matrix ($in.^2$)
Δx, Δy, Δz	deflections in x , y , and z directions, respectively (in.)
λ, μ	proportionality factors for stiffness and mass-proportional damping, respectively
$[\overline{\sigma_s \sigma_t}]$	stress covariance matrix
τ_x, τ_y, τ_{xy}	plate element shearing forces (lb/in.)
$[\Phi_\sigma(i\omega)]$	stress cross-PSD matrix
$\{\phi_{(j)}\}$	eigenvector
θ_x, θ_y, θ_z	rotations about x , y , and z axes, respectively (rad)
ω	angular frequency (rad/sec)
$\lceil \quad \rfloor$	diagonal matrix
$[\quad]^T$	transpose of matrix
$[\Phi_\delta(i\omega)]$	deflection cross-PSD matrix ($in.^2$)

I

INTRODUCTION

RANVIB is a computer program developed to aid in sonic fatigue analysis. The program employs matrix methods to calculate statistical measurements of response (deflection and stress) for complex structure subjected to random sound fields. The RANVIB system is written in FORTRAN IV and MAP languages for use on an IBM 7094 Mod II under the IBSYS Version 13 operating system.

The computer program report is in two Parts:

(1) Part I—Engineering User's Guide

(2) Part II—Computer Program Description

Part I is a guide for an engineer's use of RANVIB. Part II describes the RANVIB computer program and is intended primarily for the programmer/analyst responsible for the implementation and subsequent maintenance of the system.

Development of the theory of this program and its application to specific problems are presented in document AFFDL-TR-68-44, reference 1. An earlier study that uses portions of this program is reported in document AFFDL-TR-67-81, reference 2.

This volume is divided into four sections. Section II describes the logical and system-oriented organization of the RANVIB program. Sections III and IV describe the programming details of the FORTRAN modules of the system. Section III is a description of the modules in the phase I structural and vibration programs. Section IV describes phase II programs: the random loading module and the random response solution modules. Appendixes I and II contain descriptions and listings of the matrix manipulative scheme TL01 used throughout RANVIB, and general-purpose subroutines. Appendixes III and IV contain the listings of phase I and II programs, respectively.

II

GENERAL PROGRAM DESCRIPTION

1. PROGRAM ORGANIZATION

The RANVIB system is divided into phases I and II. Phase I (figure 1) is an integrated set of computer programs for determining the static and dynamic characteristics of the structure. Phase II (figure 2) uses results of phase I and determines sonic loads and random structural response. This division permits the analysts to assess the results of phase I before proceeding to phase II. The matrix interpretive scheme TL01 written in MAP is used to perform matrix operations in both phases.

a. Phase I—Structural and Vibration Programs

There are two major modules in phase I.

The first one MAST (matrix structural generator) generates and merges element stiffness and stress matrices and reduces unwanted freedoms to form the reduced structural stiffness, flexibility, and stress-deflection matrices. These matrices are then merged and stored on tape for later use by the FREMOD routine and phase II programs.

The second module FREMOD (frequencies and modes generator) generates natural frequencies, normal modes, and generalized masses using the flexibility matrix (MAST output tape) and mass matrix (card input).

An optional path in phase I executes only the FREMOD module using a previously calculated flexibility matrix. This option is a convenient feature when an analyst wants to change mass distribution and/or change the number of modes. A new diagonal-mass matrix is required; input is on cards.

b. Phase II—Random Load and Response Programs

This section generates the excitation cross-power spectral density (cross PSD) and the response solution options (deflection and stress cross PSD) and statistical moments.

The random pressure loads (excitations) are stored on an intermediate output tape used in the response programs. The results from phase I output tape are also used in phase II.

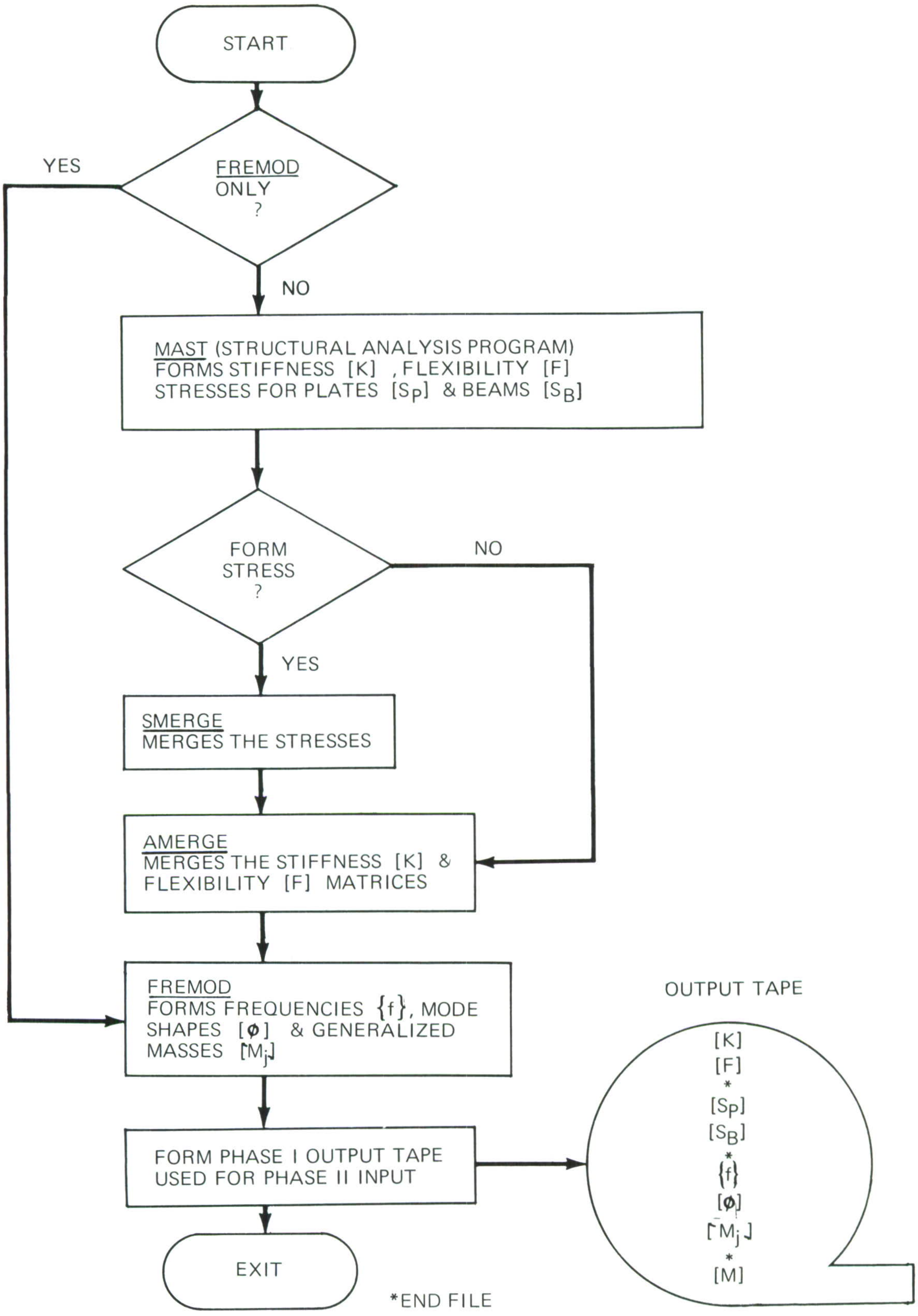

START
FREMOD ONLY ?
YES
NO
MAST (STRUCTURAL ANALYSIS PROGRAM)
FORMS STIFFNESS [K] , FLEXIBILITY [F]
STRESSES FOR PLATES [Sp] & BEAMS [SB]
FORM STRESS ?
NO
YES
SMERGE
MERGES THE STRESSES
AMERGE
MERGES THE STIFFNESS [K] &
FLEXIBILITY [F] MATRICES
FREMOD
FORMS FREQUENCIES {f}, MODE
SHAPES [φ] & GENERALIZED
MASSES ⌈Mj⌋
FORM PHASE I OUTPUT TAPE
USED FOR PHASE II INPUT
EXIT
*END FILE
OUTPUT TAPE
[K]
[F]
*
[Sp]
[SB]
*
{f}
[φ]
⌈Mj⌋
*
[M]

Figure 1. Phase I Organization

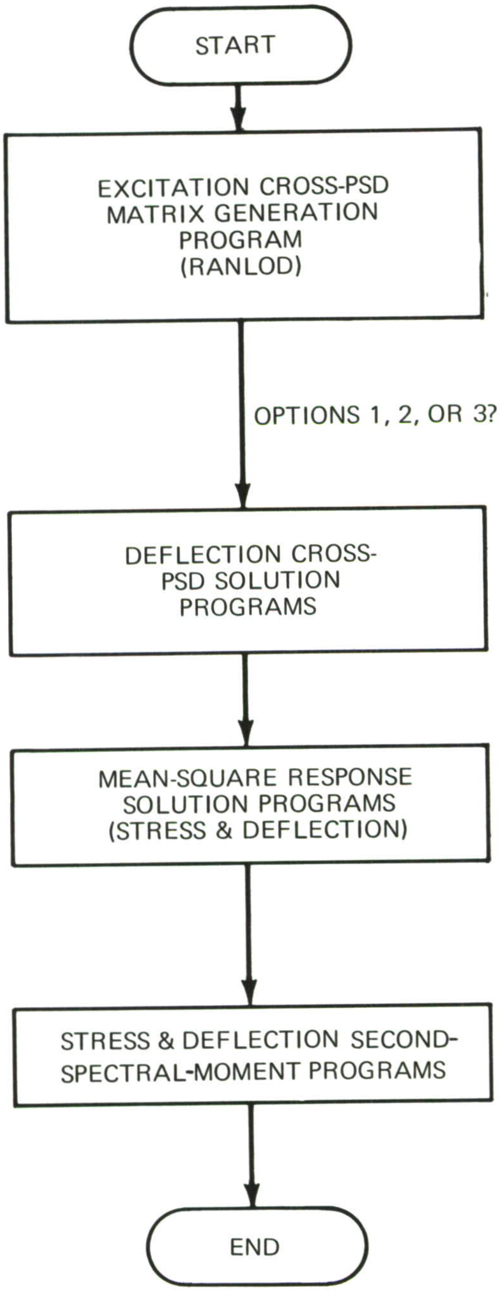

START
EXCITATION CROSS-PSD MATRIX GENERATION PROGRAM (RANLOD)
OPTIONS 1, 2, OR 3?
DEFLECTION CROSS-PSD SOLUTION PROGRAMS
MEAN-SQUARE RESPONSE SOLUTION PROGRAMS (STRESS & DEFLECTION)
STRESS & DEFLECTION SECOND-SPECTRAL-MOMENT PROGRAMS
END

Figure 2. Phase II Organization

The response solution modules are divided into three options:

(1) Option 1—General viscous damping

(2) Option 2—Normal modes

(3) Option 3—Normal modes without cross terms

Reference 3 describes the options in more detail.

Cross PSD and joint moments are formed for each option. It is also possible to generate the stress second spectral moments used in predicting fatigue life.

2. SYSTEM ORGANIZATION

a. Phase I and II Overlay Structures

The overlay structure on a subroutine basis is illustrated in figure 3. The detailed overlay structure for MAST and FREMOD are shown in figures 17 and 32, respectively (pages 36 and 67).

b. Core and Tape Requirements

The RANVIB program requires a 32K core when operating on the IBM 7094 Mod II computer under the IBSYS Version 13 system.

Tape requirements in phase I and phase II are shown in table I. Core maps of phases I and II are shown in tables II and III, respectively.

c. Deck and Master Tape Setups

(1) Operating Procedure

The following is the procedure a system analyst should follow in initiating phase I and phase II operations for the direct-coupled system (DCS).

The nine files on the phase I master tape are generated by the card-to-tape process. The first file contains binary decks, and the remaining eight files contain TL01 data decks (figure 4). Use the appropriate control cards for the DCS for phases I and II. Mount the phase I master tape on logical unit 9. The output tape from phase I will contain four files on logical unit 10.

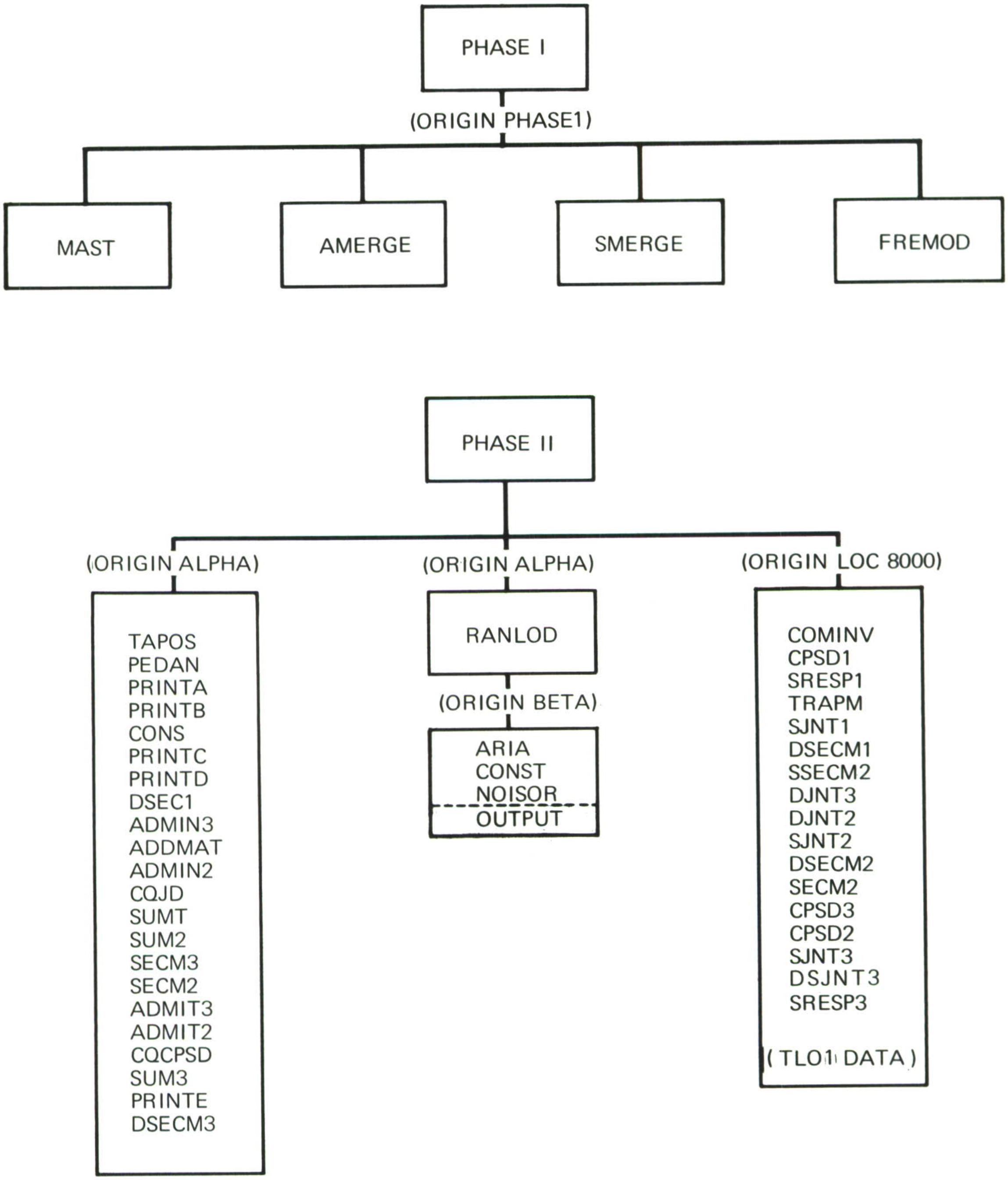

PHASE I
(ORIGIN PHASE1)
MAST
AMERGE
SMERGE
FREMOD
PHASE II
(ORIGIN ALPHA)
TAPOS
PEDAN
PRINTA
PRINTB
CONS
PRINTC
PRINTD
DSEC1
ADMIN3
ADDMAT
ADMIN2
CQJD
SUMT
SUM2
SECM3
SECM2
ADMIT3
ADMIT2
CQCPSD
SUM3
PRINTE
DSECM3
(ORIGIN ALPHA)
RANLOD
(ORIGIN BETA)
ARIA
CONST
NOISOR
OUTPUT
(ORIGIN LOC 8000)
COMINV
CPSD1
SRESP1
TRAPM
SJNT1
DSECM1
SSECM2
DJNT3
DJNT2
SJNT2
DSECM2
SECM2
CPSD3
CPSD2
SJNT3
DSJNT3
SRESP3
(TLO1 DATA)

Figure 3. Phase I and II Overlay Structures

Table I. Tape Use

Logical unit	Function
PHASE I*	
2	The parameter matrix and stiffness matrix are stored on this tape (output from MAST). This tape is also used as a scratch unit.
3	Scratch
4	Scratch
5	Standard system input tape
6	Standard system output tape
8	Stress matrices for plates from MAST
9	Program master tape
10	Phase I output tape
12	Stress matrices for beams from MAST
PHASE II**	
9	Program master tape
10	Input tape from phase I
1-4, 7-8, 11-17	Intermediate scratch tapes
5	Standard system input tape
6	Standard system output tape

*See figure 19 for tape use of logical units 1 through 16 for the MAST routine (page 43).

**Figure 43, page 84, illustrates the tape use in the phase II program.

The phase II master tape consists of seven files and is again generated by the card-to-tape process. The first file contains binary decks, and the remaining six files contain TL01 data decks (figure 5). In this operation, mount the phase II master tape on logical unit 9.

The master tapes for phases I and II are assigned to system unit SYSLB4 (logical unit 9). The system overlay is assigned to system unit SYSCK2.

Table II. Phase I Core Maps

```
SYSTEM                                    00000 THRU  02717
FILE BLOCK ORIGIN                         02720
FILES       1.      UNIT07
            2.      UNIT08
            3.      UNIT09
            4.      UNIT10
            5.      UNIT11
            6.      UNIT12
            7.      UNIT13
            8.      UNIT14
            9.      UNIT15
           10.      UNIT16
           11.      UNIT17
           12.      UNIT01
           13.      UNIT02
           14.      UNIT03
           15.      UNIT04
           16.      UNIT05
           17.      UNIT06
FILE LIST ORIGIN                          03234
PRE-EXECUTION INITIALIZATION              03262
CALL ON OBJECT PROGRAM                    03321
OBJECT PROGRAM                            03326 THRU  71152

LINK  DECK     ORIGIN    CONTROL SECTIONS   (/NAME/=NON 0 LENGTH, (LOC)=DELETED, *=NOT REFERENCED)

 0    BLK       03326    /TAPES / 03326    /REDUC / 03347
      PHASE1    03351    /PRNT  / 03352     ......  03636 *
      WRTETP    03650     WRTETP (03650)
      READTP    04324     READTP (04324)
      FVIO      04677     .FVIO.  04677
      FILE      05014     .UN07.  05014     .UN08.  05015      .UN09.  05016      .UN10.  05017      .UN11.  05020
                          .UN12.  05021     .UN13.  05022      .UN14.  05023      .UN15.  05024      .UN16.  05025
                          .UN17.  05026
      .LINK     05027    /.LDT  / 05027    /.LRECT/ 05062     /.LVEC / 05156
      .LXCON    05244     .LXSTR  05244     .LXSTP  05247      .LXOUT  05315      .LXERR  05324      .LXCAL  05327 *
                          .LXRTN  05327     IBEXIT  05327 *    .DBCLS  05511 *    .LXARG  05663      .LO     05706 *
                          .CLSE   05714     .LFBL   05715 *    .LUNB   05716      .DFCUT  05717
      .IODEF    05723     .DEFIN  05723     .ATTAC  05727 *    .CLOSE  05731      .OPEN   05733      .READ   05735
                          .WRITE  05737     .BSR    05747      .READR  05757 *    .RELES  05761 *    .LAREA  05772 *
                          .LFBLK  06010     .LTSX   06013 *    .AREA1  06025      .LUNBL  06033 *    .ENTRY  06037
                          .GOA    06072     .GO     06076      .DERR   06112      .NOPXI  06113      .COMXI  06115
                          .EX34   06137
```

Table II–Continued

.IOCSF	06144										
.LOVRY	10446	.LOVRY	(10446)	.LDT	(05027)	.LRECT	(05062)	.LVEC	(05156)		
.LXSL	11154	.LXSEL	11154	.LXSL1	11155	.LXTST	11160 *	.LXOVL	11220 *	.LXMOD	11262 *
		.LXIND	11306	.LXDIS	11311	.LKFLG	11312	.LTCH	11313		
.FPTRP	11321	.FFPT.	11321 *	.FPOUT	11456	.FPARG	11464	/.COUNT/	11466 *	OVFLOW	11532
XIT	11541	EXIT	11541	.EXIT.	11541						
FXEM	11542	.FXEM.	11542	.FXOUT	12077	.FXARG	12105	/.OPTW./	12161 *		
FOUT	12172	.FOUT.	12172								
FCNV	12561	.FCON.	12561	.FCNV.	12604	.ENDFS	12617	.CNVSW	12621	.FDX1	12625
		.FDX2	12626	.DBC	12630	.DBC10	12766	.DBC20	13014	.DDSW	13024
		.DDFIX	13033	.FIXSW	13041	.DDBC	13116	.DDRS1	13361	.DDRS2	13363 *
		.D1	13366	.D2	13370	.FERR2	13455 *	.ANPT	13511	.ONPT	13526
		.LNTP	13611	.AOUT	13660	.DFLT	13676	.FLT	14032	.DEXPN	14122
		.FXD	14123	.HOUT	14253	.INTG	14323	.LOUT	14441	.DOUT	14460
		.XCF	14511	.TEST	15217	.KOUNT	15222	.LIST	15225	.DONE	15236
		.OUTBF	15302	.BUF	15332	.QSTO	15333	.WIDTH	15334	.GAIN	15335
		.GAIN1	15336	.FBDBF	15346	.DDDFL	15372	.DDFLG	15373	.MQD	15374
		.PEX	15375	.FEXP	15376	.DIG	15377				
FIDB	15415	.FIDB.	15415	.FCNT	15520	.FBLT.	15616	.FBDT.	15636	.FRLR.	15662
		.FRLR.	(15662)	.FWLR.	15726	.FWLR.	(15726)	.FBIBF	15766	.FRITE	16060
FIOS	16066	.FIOS.	16066	.FSEL.	16226	.FILR.	16232 *	.FRTB.	16241	.FRTO.	16246
		.FILL.	16251	.FCLS	16253 *	.FOPN	16257 *	REOF	16263 *	.TOUT.	16426
		.REED	16434 *	.BIN	16435 *	.FCT	16436	.FCKSZ	16440		
FIOH	16522	.FIOH.	16522	.FFIL.	17307	.FRTN.	17334				
FWRD	17532	.FWRD.	17532								
FWRB	17556	.FWRB.	17556								
FRDD	17602	.FRDD.	17602								
FRDB	17630	.FRDB.	17630								
FPRN	17654	.FPRN.	17654								
UN01	20013	.UN01.	20013								
UN02	20014	.UN02.	20014								
UN03	20015	.UN03.	20015								
UN04	20016	.UN04.	20016								
UN05	20017	.UN05.	20017								
UN06	20020	.UN06.	20020	.BUFSZ	20021						
FSQR	20024	SQRT	20024								
FBST	20077	.FBST.	20077								
FEFT	20314	.FEFT.	20314								
FRWT	20414	.FRWT.	20414								
FSLDI	20521	.FSLI.	20537	.FSDI.	20545 *						
FSLBI	20556	.FBLI.	20574	.FBDI.	20602 *						
FSLI	20614	.SLI.	20614	.SLI1.	20621	.SDI.	20627	.SDI1.	20635		
FSLDO	20650	.FSLO.	20666	.FSDO.	20674 *						
FSLBO	20705	.FBLO.	20723	.FBDO.	20731 *						
FSLO	20743	.SLO.	20743	.SLO2.	20751	.SDO.	20756	.SDO2.	20765		
FDVCHK	20777	DVCHK	20777								
FOVERF	21016	OVERFL	21016								

Table II–Continued

	FASNCS	21040	ASIN 21040	ACOS 21042 *	/ERASE / 21171		
	FBSF	21215	BSF 21217	/ERASE /(21171)			
	FFSF	21334	FSF 21336	/ERASE /(21171)			
	FFSR	21420	FSPR 21422 *	FSR 21424	/ERASE /(21171)		
	FKRD	21505	KRD 21507	KRDG 21511 *	CART 21512 *		
	FRUN	22326	UNLOAD 22330	/ERASE /(21171)			
1	MAST*	22355	/RENT / 22356	/MAPSTR/ 22360	/CONT1 / 22362	/LASTND/ 24022	/COMS / 24332
			/TERMS / 24642	/CONTRL/ 24655	/TAPES /(03326)	/TITL / 24665	/PAGE / 24702
			/REDUC /(03347)	MAST 26002			
	PAGH*	26016	/TITL /(24665)	/TAPES /(03326)	/PAGE /(24702)	PAGHED 26066	
	UNPAC*	26100	UNPACK 26210				
	PRINT*	26246	PRINT 26601				
2	SUBM1*	26636	/CONT1 /(22362)	/CONT2 / 26637	/CONT3 / 30277	/RENT /(22356)	/LASTND/(24022)
			/COMS /(24332)	/TERMS /(24642)	/CONTRL/(24655)	/SKIP / 31737	/NOMERG/ 31743
			SUBM1 31774				
3	GENRA*	32006	/CONT1 /(22362)	/CONT2 /(26637)	/CONT3 /(30277)	/LASTND/(24022)	/CORD / 32007
			/CONTRL/(24655)	/TERMS /(24642)	/ADPRO / 45567	/SSTR / 45575	/CHECK / 45577
			/TAPES /(03326)	/FLAG / 45601	/TITL /(24665)	GENRAT 45727	
	REDUC*	45741	REDUCE 46136				
4	INFO*	46171	/CONT1 /(22362)	/CONT2 /(26637)	/CONT3 /(30277)	/LASTND/(24022)	/CORD /(32007)
			/CONTRL/(24655)	/TERMS /(24642)	/TAPES /(03326)	/TITL /(24665)	/REDUC /(03347)
			INFO 47266				
5	PLATE*	46171	/RENT /(22356)	/CONT1 /(22362)	/CONT3 /(30277)	/LASTND/(24022)	/TAPES /(03326)
			/CORD /(32007)	/TERMS /(24642)	/ADPRO /(45567)	/SSTR /(45575)	/PSTIF2/ 46172
			/PSTIF1/ 46174	/PSTIF8/ 47274	/PSTIF9/ 51100	/PSTIFC/ 51102	/PSTIFD/ 51105
			/PSTIFG/ 51110	/PMTR1 / 51124	/STRAN / 51135	/FLAG /(45601)	/PSTIFL/ 51435
			/SWAP / 51436	/PSTIFH/ 51437	/TITL /(24665)	/BUCK / 51447	/THRST / 51450
			PLATE 55026				
	MUL1*	55047	MUL1 55235				
	MUL2*	55274	MUL2 55457 *				
	PSTIF*	55515	/RENT /(22356)	/TPLN1 / 55516	/PSTIFL/(51435)	/PSTIF9/(51100)	PSTIF 55562
	QUAD*	55576	/PSTIF2/(46172)	/ADPRO /(45567)	/PSTIF3/ 55577	/PSTIF5/ 55605 *	/PSTIF8/(47274)
			/PSTIFH/(51437)	/PSTIFK/ 55651	/PSTIFL/(51435)	/TEMP2 / 55652 *	/TPLN1 /(55516)
			/RENT /(22356)	/SWAP /(51436)	/LOAD / 56422 *	QUAD 56651	
	LAMK*	56667	LAMK 56757				
	KLAMT*	57013	KLAMT 57117				
	TRI*	57157	/PSTIF1/(46174)	/PSTIF3/(55577)	/PSTIF7/ 57160	/PSTIF9/(51100)	/PSTIFH/(51437)
			/PSTIFD/(51105)	/BUCK /(51447)	/THRST /(51450)	TRI 57473	
	INP*	57511	/PSTIFA/ 57512	/PSTIFB/ 57556	INP 57721		
	INPM*	57733	/PSTIF2/(46172)	/ADPRO /(45567)	/PSTIF7/(57160)	/PSTIF9/(51100)	/PSTIFB/(57556)

Table II–Continued

			/PSTIFD/(51105)	INPM 60744			
	INPST*	60762	/PSTIF2/(46172)	/ADPRO /(45567)	/PSTIF7/(57160)	/PSTIF9/(51100)	/PSTIFA/(57512)
			/PSTIFC/(51102)	/PSTIFD/(51105)	INPST 61534		
	OUTP*	61550	/PSTIFA/(57512)	/PSTIFB/(57556)	OUTP 61573		
	OUTPM*	61605	/PSTIFA/(57512)	/PSTIFC/(51102)	/PSTIFD/(51105)	OUTPM 61725	
	OUTPS*	61741	/PSTIF2/(46172)	/ADPRO /(45567)	/PSTIF7/(57160)	/PSTIFB/(57556)	OUTPSH 62561
	COMBI*	62573	/PSTIFA/(57512)	/PSTIFB/(57556)	COMBIN 62763		
	STORE*	63013	/PSTIF1/(46174)	/PSTIF8/(47274)	/PSTIF9/(51100)	/PSTIFB/(57556)	/PSTIFK/(55651)
			STORE 63640				
	MOVE*	63667	MOVE 64001				
	PMTR*	64025	/PMTR1 /(51124)	/PSTIF9/(51100)	/PSTIFG/(51110)	PMTR 64373	
	SMTR*	64407	/PSTIF9/(51100)	/PSTIFH/(51437)	/STRAN /(51135)	SMTR 65634	
	LOCAL*	65655	/RENT /(22356)	/PSTIF9/(51100)	/PSTIFG/(51110)	/PSTIFH/(51437)	/PSTIFL/(51435)
			/TAPES /(03326)	LOCAL 66421			
	COPLA*	66433	/PSTIF9/(51100)	/PSTIFG/(51110)	/PSTIFH/(51437)	/NOMERG/(31743)	/CHECK /(45577)
			/TAPES /(03326)	COPLAN 66712			
6	FSCN	46171	COS 46171	SIN 46172			
	FXP2	46365	.XP2. 46365				
	BEAM*	46503	/TITL /(24665)	/CONT1 /(22362)	/CONT2 /(26637)	/LASTND/(24022)	/CORD /(32007)
			/TERMS /(24642)	/TAPES /(03326)	/PROPT / 46504	/ADPRO /(45567)	/SSTR /(45575)
			/VAR / 47634	/N3N3 / 47636	/FLAG /(45601)	BEAM 56015	
	TINVR*	56040	TINVR 56642				
	SMULT*	56746	SMULT 57126				
	MULT*	57161	MULT 57513				
	SBMTR*	57570	/TAPES /(03326)	/VAR /(47634)	/ADPRO /(45567)	/N3N3 /(47636)	SBMTR 60361
	SSTIF*	60501	/VAR /(47634)	/ADPRO /(45567)	/PROPT /(46504)	SSTIF 61242	
	MAD*	61410	MAD 61426				
	SBGS*	61453	SBGS 61642				
	OFST*	61772	OFST 62115				
	CSTIF*	62232	/TAPES /(03326)	/VAR /(47634)	/ADPRO /(45567)	/PROPT /(46504)	CSTIF 63511
	CBMTR*	63610	/TAPES /(03326)	/VAR /(47634)	/ADPRO /(45567)	/LTRAN / 63611 *	CBMTR 64775
7	MERGE*	32006	/CONT1 /(22362)	/CONT2 /(26637)	/CONT3 /(30277)	/LASTND/(24022)	/CONTRL/(24655)
			/TERMS /(24642)	/COMS /(24332)	/SKIP /(31737)	/TAPES /(03326)	/REDUC /(03347)
			MERGE 32336				
	SOR*	32352	SOR 32501				
8	MERGB*	32550	/CONT1 /(22362)	/CONT2 /(26637)	/CONT3 /(30277)	/COMS /(24332)	/LASTND/(24022)
			/TERMS /(24642)	/CONTRL/(24655)	/TAPES /(03326)	MERGBC 71124	
9	STRES*	32550	/TERMS /(24642)	/CONTRL/(24655)	/SKIP /(31737)	/PBSIZE/ 32551	/TAPES /(03326)
			/LOADS / 32556	STRESS 46116			
	MSTRE*	46130	/CONTRL/(24655)	/LASTND/(24022)	/TERMS /(24642)	/SKIP /(31737)	/PBSIZE/(32551)
			/TAPES /(03326)	/MAPSTR/(22360)	/LOADS /(32556)	MSTRES 55741	
10	SORCON	26636	/SORT / 26637	/TERMS /(24642)	/TAPES /(03326)	/COMS /(24332)	/CONT1 /(22362)
			/RSIZE / 45517	/MAPSTR/(22360)	/CONTEM/ 47014	/REDUC /(03347)	SOLN 47132
	TEST*	47144	TEST 47226				

Table II–Concluded

11	FKSRT	47263	/LASTND/(24022)	/TERMS /(24642)	/TAPES /(03326)	/SORT /(26637)	/CONT1 /(22362)
			/CONTEM/(47014)	/CCMS /(24332)	FKSORT 52065		
12	KFSRT	47263	/SORT /(26637)	/TAPES /(03326)	/TERMS /(24642)	/COMS /(24332)	/CONT1 /(22362)
			/CONTEM/(47014)	KFFSRT 67356			
13	CNCT*	47263	/SORT /(26637)	/TERMS /(24642)	/TAPES /(03326)	/COMS /(24332)	CONECT 50667
14	EXPND*	50703	EXPAND 67465				
15	EXTRN*	50703	EXTRAN 70134				
16	DELET*	47263	/TAPES /(03326)	/TERMS /(24642)	/RSIZE /(45517)	/LASTND/(24022)	/MAPSTR/(22360)
			/TEMPO / 47264	DELETE 64251			
	SSORT*	64315	/SORT /(26637)	/TAPES /(03326)	/TERMS /(24642)	/RSIZE /(45517)	/COMS /(24332)
			/MAPSTR/(22360)	/TEMPO /(47264)	SSORT 65724		
17	HELP	26636	TL01 26636				
	YTLOSB	26664	YTL01 26664 *	YTL01 26665	MMM 27122 *	ERRCDE 34437 *	TAPE 34441 *
	INVERT	35420	INV4DS 35420				
	DATASB	36540	DATA 36540				
18	FREMO*	22355	FREMOD 57453				
	WDVALV	57474	VALVCT 60645				
	INRPRD	60724	INRPRD (60724)	PRDSUM 60744 *			
19	WDHESS	61020	HESSEN 61517				
20	WDQRIT	61020	QRITER 62210				
21	WDSORT	61020	SORTRT 61310				
22	WDVECT	61020	VECTOR 61453				
23	WDTRN1	61020	TRANS1 61423				
24	WDTRN2	61020	TRANS2 61376				
25	AMERG*	22355	/PRNT /(03352)	AMERGE 55533			
26	SMERG*	22355	/PRNT /(03352)	SMERGE 63005			
I/O BUFFERS			71153 THRU 77772				
UNUSED CORE			77773 THRU 77777				

Table III. Phase II Core Maps

```
SYSTEM                                   00000 THRU  02717
FILE BLOCK ORIGIN                        02720
FILES         1.      UNIT07
              2.      UNIT08
              3.      UNIT09
              4.      UNIT10
              5.      UNIT11
              6.      UNIT12
              7.      UNIT13
              8.      UNIT14
              9.      UNIT15
             10.      UNIT16
             11.      UNIT17
             12.      UNIT01
             13.      UNIT02
             14.      UNIT03
             15.      UNIT04
             16.      UNIT05
             17.      UNIT06
FILE LIST ORIGIN                         03234
PRE-EXECUTION INITIALIZATION             03276
CALL ON OBJECT PROGRAM                   03327
OBJECT PROGRAM                           03334 THRU  65757

LINK  DECK    ORIGIN    CONTROL SECTIONS  (/NAME/=NON 0 LENGTH, (LOC)=DELETED, *=NOT REFERENCED)

  0   PHASE2  03334    /BLK1   / 03335   /BLK2   / 03563    /BLK3   / 03575    ......  06111 *
      SCALE*  06125     SCALE    06203
      FVIO    06232     .FVIO.   06232
      FILE    06347     .UN07.   06347    .UN08.   06350     .UN09.   06351     .UN10.   06352     .UN11.   06353
                        .UN12.   06354    .UN13.   06355     .UN14.   06356     .UN15.   06357     .UN16.   06360
                        .UN17.   06361
      READTP  06362     READTP (06362)
      WRTETP  06735     WRTETP (06735)
      .LINK   07411    /.LDT   / 07411   /.LRECT/ 07445     /.LVEC / 07533
      .LXCON  07621     .LXSTR   07621    .LXSTP   07624     .LXOUT   07672     .LXERR   07701     .LXCAL   07704 *
                        .LXRTN   07704    IBEXIT   07704 *   .DBCLS   10066 *   .LXARG   10240     .LO      10263 *
                        .CLSE    10271    .LFBL    10272 *   .LUNB    10273     .DFOUT   10274
      .IODEF  10300     .DEFIN   10300    .ATTAC   10304 *   .CLOSE   10306     .OPEN    10310     .READ    10312
                        .WRITE   10314    .BSR     10324 *   .READR   10334 *   .RELES   10336 *   .LAREA   10347 *
                        .LFBLK   10365    .LTSX    10370 *   .AREA1   10402     .LUNBL   10410 *   .ENTRY   10414
                        .GOA     10447    .GO      10453     .DERR    10467     .NOPXI   10470     .COMXI   10472
                        .EX34    10514
      .IOCSF  10521
      .LOVRY  13023     .LOVRY (13023)    .LDT    (07411)    .LRECT (07445)     .LVEC   (07533)
      .LXSL   13531     .LXSEL   13531    .LXSL1   13532     .LXTST   13535 *   .LXOVL   13575 *   .LXMOD   13637 *
                        .LXIND   13663    .LXDIS   13666     .LXFLG   13667     .LTCH    13670
```

Table III–Continued

.FPTRP	13676	.FFPT.	13676 *	.FPOUT	14033	.FPARG	14041	/.COUNT/	14043 *	OVFLOW	14107 *
.ERAS.	14116	E.1	14116	E.2	14117	E.3	14120	E.4	14121		
.XCC.	14122	CC.1	14122	CC.2	14123	CC.3	14124	CC.4	14125		
XIT	14126	EXIT	14126	.EXIT.	14126 *						
FXEM	14127	.FXEM.	14127	.FXOUT	14464	.FXARG	14472	/.OPTW./	14546 *		
FOUT	14557	.FOUT.	14557								
FCNV	15146	.FCON.	15146	.FCNV.	15171	.ENDFS	15204	.CNVSW	15206	.FDX1	15212
		.FDX2	15213	.DBC	15215	.DBC10	15353	.DBC20	15401	.DDSW	15411
		.DDFIX	15420	.FIXSW	15426	.DDBC	15503	.DDRS1	15746	.DDRS2	15750 *
		.D1	15753	.D2	15755	.FERR2	16042 *	.ANPT	16076	.ONPT	16113
		.LNTP	16176	.AOUT	16245	.DFLT	16263	.FLT	16417	.DEXPN	16507
		.FXD	16510	.HOUT	16640	.INTG	16710	.LOUT	17026	.DOUT	17045
		.XCF	17076	.TEST	17604	.KOUNT	17607	.LIST	17612	.DONE	17623
		.OUTBF	17667	.BUF	17717	.QSTO	17720	.WIDTH	17721	.GAIN	17722
		.GAIN1	17723	.FBDBF	17733	.DDDFL	17757	.DDFLG	17760	.MOD	17761
		.PEX	17762	.FEXP	17763	.DIG	17764				
FIOB	20002	.FIOB.	20002	.FCNT	20105	.FBLT.	20203	.FBDT.	20223	.FRLR.	20247
		.FRLR.	(20247)	.FWLR.	20313	.FWLR.	(20313)	.FBIBF	20353	.FRITE	20445
FIOS	20453	.FIOS.	20453	.FSEL.	20613	.FILR.	20617 *	.FRTB.	20626	.FRTD.	20633
		.FILL.	20636	.FCLS	20640 *	.FOPN	20644 *	REOF	20650 *	.TOUT.	21013
		.REED	21021 *	.BIN	21022 *	.FCT	21023	.FCKSZ	21025		
FIOH	21107	.FIOH.	21107	.FFIL.	21674	.FRTN.	21721				
FWRD	22117	.FWRD.	22117								
FWRB	22143	.FWRB.	22143								
FRDD	22167	.FRDD.	22167								
FRDB	22215	.FRDB.	22215								
FPRN	22241	.FPRN.	22241								
UNO1	22400	.UNO1.	22400								
UNO2	22401	.UNO2.	22401								
UNO3	22402	.UNO3.	22402								
UNO4	22403	.UNO4.	22403								
UNO5	22404	.UNO5.	22404								
UNO6	22405	.UNO6.	22405	.BUFSZ	22406						
FLOG	22411	ALOG10	22411 *	ALOG	22412						
FXPF	22615	EXP	22615								
FSCN	22736	COS	22736	SIN	22737						
FSQR	23132	SQRT	23132								
FXP1	23205	.XP1.	23205								
FEFT	23321	.FEFT.	23321								
FRWT	23421	.FRWT.	23421								
FSLDI	23526	.FSLI.	23544	.FSDI.	23552 *						
FSLBI	23563	.FBLI.	23601	.FBDI.	23607 *						
FSLI	23621	.SLI.	23621	.SLI1.	23626	.SDI.	23634	.SDI1.	23642		
FSLDO	23655	.FSLO.	23673	.FSDO.	23701 *						
FSLBO	23712	.FBLO.	23730	.FBDO.	23736 *						
FSLO	23750	.SLO.	23750	.SLO2.	23756	.SDO.	23763	.SDO2.	23772		
FASNCS	24004	ASIN	24004	ACOS	24006 *	/ERASE /	24135				
FBSF	24161	BSF	24163	/ERASE /	(24135)						

Table III–Continued

	FFSF	24300	FSF	24302	/ERASE	/(24135)						
	FFSR	24364	FSPR	24366 *	FSR	24370	/ERASE	/(24135)				
	FKRD	24451	KRD	24453	KRDG	24455 *	CART	24456 *				
	FRUN	25272	UNLOAD	25274	/ERASE	/(24135)						
1	HELP	25321	TLO1	25321								
	YTLOSB	25347	YTLO1	25347 *	YTLO1	25350	MMM	25605 *	ERRCDE	33122 *	TAPE	33124 *
	INVERT	34103	INV4DS	34103								
	DATASB	35223	DATA	35223								
2	TAPOS*	25321	/BLK3	/(03575)	TAPOS	25435						
3	RANLO*	25321	/BLK1	/(03335)	/BLK2	/(03563)	/BLK3	/(03575)	/BLK4	/ 25322	/BLK5	/ 25347
			/BLK6	/ 26031	RANLOD	64306						
4	ARIA**	64322	/BLK1	/(03335)	/BLK2	/(03563)	/BLK3	/(03575)	/BLK4	/(25322)	/BLK5	/(25347)
			/BLK6	/(26031)	ARIA	64405						
5	CONST*	64322	CONST	64423								
6	NOISO*	64322	/BLK1	/(03335)	/BLK2	/(03563)	/BLK3	/(03575)	/BLK4	/(25322)	/BLK5	/(25347)
			/BLK6	/(26031)	NOISOR	65050						
	OUTPUT	65123	/BLK1	/(03335)	/BLK2	/(03563)	/BLK3	/(03575)	/BLK4	/(25322)	/BLK5	/(25347)
			/BLK6	/(26031)	OUTPT	65665 *						
7	PEDAN*	25321	/BLK1	/(03335)	/BLK2	/(03563)	PEDAN	65735				
8	PRNTA*	25321	/BLK1	/(03335)	/BLK2	/(03563)	PRINTA	45551				
9	PRNTB*	25321	/BLK1	/(03335)	/BLK2	/(03563)	/BLK3	/(03575)	PRINTB	26273		
10	CONS*	25321	/BLK1	/(03335)	/BLK2	/(03563)	CONS	26003				
11	PRNTC*	25321	/BLK2	/(03563)	PRINTC	45465						
12	PRNTD*	25321	/BLK1	/(03335)	/BLK2	/(03563)	/BLK3	/(03575)	PRINTD	26117		
13	DSEC1*	25321	/BLK1	/(03335)	/BLK2	/(03563)	DSECM1	65731				
14	ADMN3*	25321	/BLK1	/(03335)	/BLK2	/(03563)	/BLK3	/(03575)	ADMIN3	32774		
15	ADDMA*	25321	/BLK1	/(03335)	/BLK2	/(03563)	/BLK3	/(03575)	ADDMAT	65604		
16	ADMN2*	25321	/BLK1	/(03335)	/BLK2	/(03563)	ADMIN2	42552				
17	COJD*	25321	/BLK2	/(03563)	COJD	65565						
18	SUMT*	25321	/BLK2	/(03563)	SUMT	65436						

Table III–Concluded

19	SUM2*	25321	/BLK2 /(03563)	SUM2 65565		
20	SECM3*	25321	/BLK1 /(03335)	/BLK2 /(03563)	SECM3 32657	
21	SECM2*	25321	/BLK1 /(03335)	/BLK2 /(03563)	SECM2 42426	
22	ADMT3*	25321	/BLK1 /(03335)	/BLK2 /(03563)	/BLK3 /(03575)	ADMIT3 33316
23	ADMT2*	25321	/BLK1 /(03335)	/BLK2 /(03563)	ADMIT2 42053	
24	CQCPS*	25321	/BLK2 /(03563)	CQCPSD 65644		
25	SUM3*	25321	/BLK1 /(03335)	/BLK2 /(03563)	SUM3 65535	
26	PRNTE*	25321	/BLK1 /(03335)	/BLK2 /(03563)	/BLK3 /(03575)	PRINTE 26161
27	DSECM*	25321	/BLK1 /(03335)	/BLK2 /(03563)	DSECM3 65414	

I/O BUFFERS	65760 THRU 77767
UNUSED CORE	77770 THRU 77777

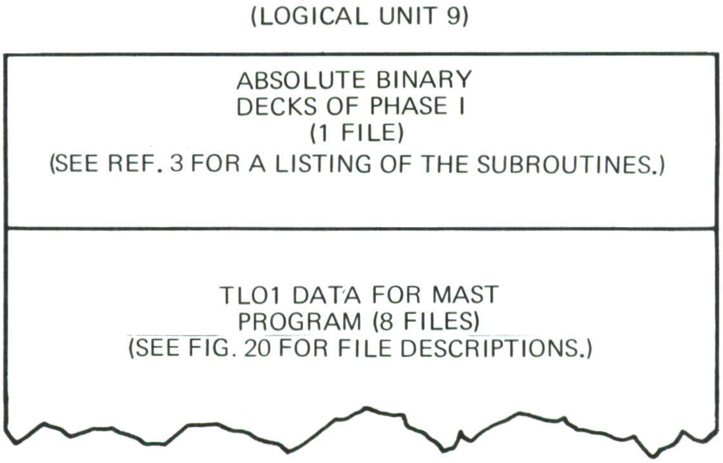

(LOGICAL UNIT 9)
ABSOLUTE BINARY DECKS OF PHASE I (1 FILE)
(SEE REF. 3 FOR A LISTING OF THE SUBROUTINES.)
TL01 DATA FOR MAST PROGRAM (8 FILES)
(SEE FIG. 20 FOR FILE DESCRIPTIONS.)

Figure 4. Phase I Master Tape

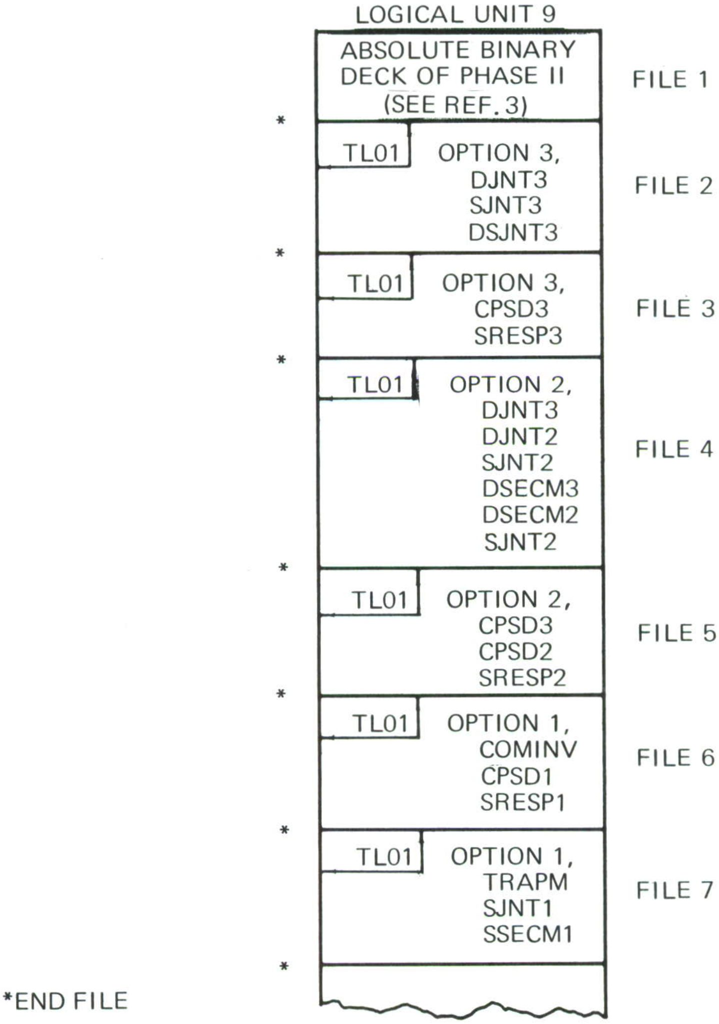

LOGICAL UNIT 9
ABSOLUTE BINARY DECK OF PHASE II (SEE REF. 3)
FILE 1
TL01
OPTION 3, DJNT3 SJNT3 DSJNT3
FILE 2
TL01
OPTION 3, CPSD3 SRESP3
FILE 3
TL01
OPTION 2, DJNT3 DJNT2 SJNT2 DSECM3 DSECM2 SJNT2
FILE 4
TL01
OPTION 2, CPSD3 CPSD2 SRESP2
FILE 5
TL01
OPTION 1, COMINV CPSD1 SRESP1
FILE 6
TL01
OPTION 1, TRAPM SJNT1 SSECM1
FILE 7
*
*END FILE

Figure 5. Phase II Master Tape

(2) Input/Output Editor

The input/output editor ($IEDIT) is used for two functions: (1) to read information off the master tape, and (2) to assist the programmer in modifying existing subroutines.

When used to read information off the master tape, the $IEDIT card precedes the component control card of the deck that is affected. The specifications on the control card remain in effect until the end of the application or until another $IEDIT card changes the specifications. The format of the $IEDIT card with optional instructions starting in column 16 for the RANVIB system is:

```
          2 4 6 —  —  —  16 18 20 22 24 26 —  —  — 80
Column:  1 3 5  —  —  —   17 19 21 23 25   —  —  —
         $IEDIT—  —  —  SYSLB4, SRCH —  —  —
```

The following procedure should be followed when an analyst/programmer wants to change any source or binary subroutines.

(a) Pull the appropriate $IBLDR card out of the phase I/phase II control deck.

(b) Insert a $IEDIT card with no optional instructions (columns 16 and on are blank).

(c) Insert the modified subroutine source or binary deck.

Insert a $IEDIT card with optional instructions SYSLB4, SRCH (see the example above).

```
[Col 1       Col 16      ]
[   $IEDIT      SYSLB4,SRCH]
```

III

PHASE I—STRUCTURAL AND VIBRATION PROGRAMS

Phase I is an integrated set of computer programs for determining the static and dynamic characteristics of the structure. The execution of this phase is controlled by the PHASE1 subroutine. The MAST module, FREMOD module, and intermediate matrix merge programs are called from the control program. The program listings for phase I are included in appendix III.

1. MATRIX STRUCTURAL GENERATOR PROGRAM (MAST)

a. General Description

The purpose of the MAST module is to generate and merge element stiffness and stress matrices and to reduce out unwanted freedoms.

The input is in card form and describes the physical structure in terms of nodes connected by beams and plates. Other inputs are boundary conditions that fix the structure in space and retained-freedom information that specifies the freedoms to be retained in the final matrices. The output is via tape to the other modules and includes the reduced stiffness matrix, flexibility matrix, and stress matrices for both beams and plates.

The module is divided into four segments. The first segment (generation) generates elemental stiffness and stress matrices for beam and plate elements. The second segment (merge) merges these elemental matrices to form the structural stiffness and stress matrices and deletes the constrained freedoms from the stiffness matrix. The third segment (sorting) sorts the stiffness and stress matrices into retained and reduced partitions. The final segment (reduction) then performs the actual equation solving necessary for reduction.

The module is restricted to a maximum of 2,000 nodes and 7,000 retained freedoms. The number of beam and plate elements is unrestricted. These limits are set by core storage limitations, and any attempt to run problems in this size range may be restricted by machine reliability and the peripheral storage size of the computer being used.

b. Major Program Functions

(1) Elemental-Matrix Generation

(a) Beam Matrices

The elemental matrices for beams are generated one at a time in the order that the input data are read. This generation includes the various transformation matrices and the stiffness matrix in local coordinates. The first transformation matrix generated (if offsets are present) is the offset transformation from the beam's neutral axis location to node point location. Next, the stress-transformation matrix and local-stiffness matrix are generated. The offset transformation is then applied to the stress transformation and this premultiplies the local-stiffness matrix to obtain the beam-stress matrix. This beam-stress matrix is finally premultiplied by the transpose of the combined offset and stress-transformation matrix to obtain the stiffness matrix in structural coordinates.

These matrices are then written on tape for later use by the merge segment. The structure of these elemental matrices is as shown in figures 6 and 7.

Each beam is also checked to determine which partitions of the merged stiffness matrix it will contribute to. A list of partitions is created that contains partition identification numbers for the partitions having non-null elements. This list is updated when elements are found that will contribute to partitions not already in the list.

(b) Plate Matrices

The plate-element matrices are also generated one plate at a time in the order that the input data are read. The elemental stiffness matrix in local coordinates is first generated and then the coordinate and stress-transformation matrices are generated. In generating the stiffness for quadrilateral plates, the program subdivides the quadrilateral into four triangles (figure 8) with a fifth "dummy" node placed at the centroid. The four triangles are then merged to form the local-stiffness matrix for the quadrilateral plate, and the terms for the fifth node are reduced out. Next, the local-stiffness matrix is post multiplied by the transpose of the coordinate-transformation matrix and this result is saved.

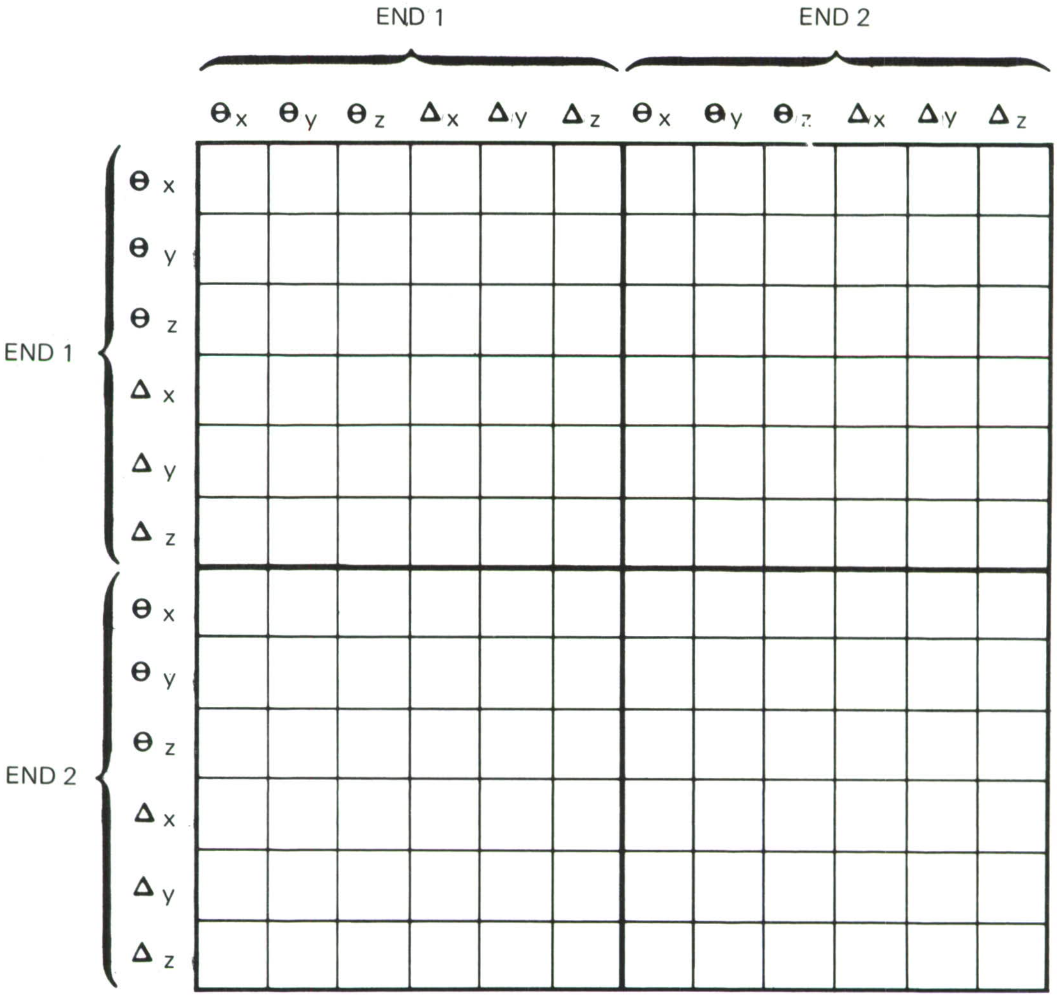
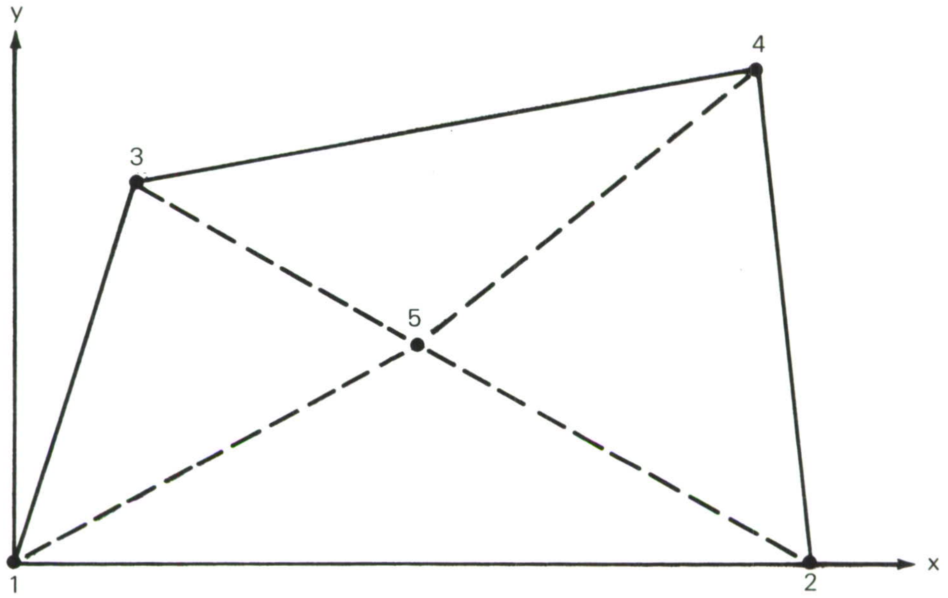

END 1
END 2
Θx
Θy
Θz
Δx
Δy
Δz
Θx
Θy
Θz
Δx
Δy
Δz
END 1
Θ x
Θ y
Θ z
Δ x
Δ y
Δ z
END 2
Θ x
Θ y
Θ z
Δ x
Δ y
Δ z

Figure 6. Elemental Beam Stiffness Matrix Layout

		END 1						END 2						
		θ_x	θ_y	θ_z	Δ_x	Δ_y	Δ_z	θ_x	θ_y	θ_z	Δ_x	Δ_y	Δ_z	
END 1	M_x													12
	M_y													
	M_z													
	F_x													
	F_y													
	F_z													
END 2	M_x													
	M_y													
	M_z													
	F_x													
	F_y													
	F_z													
		12												

Figure 7. Elemental Beam Stress Matrix Layout



NOTE: NODE 5 IS AT CENTROID OF PLATE.

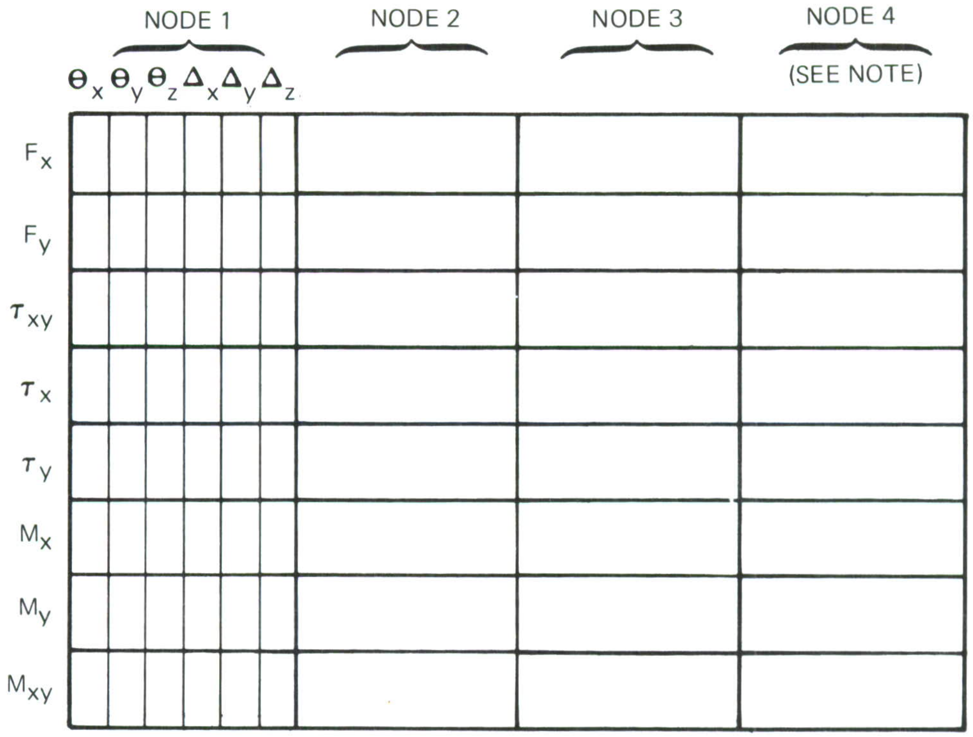
Figure 8. Quadrilateral Plate Layout

This intermediate result is then premultiplied by the stress-transformation matrix producing the elemental stress matrix (figure 9) that is saved on tape. The coordinate transformation of the stiffness matrix is then completed by premultiplying the product of the local-stiffness matrix and the transpose of the coordinate-transformation matrix by the coordinate-transformation matrix, resulting in an elemental stiffness matrix in structural coordinates (figure 10). This result is then saved on tape. As with the beams, each plate is checked to see which partitions of the merged matrix it will contribute to, and the connectivity data are updated accordingly.

(2) Structural Matrix Formation

(a) Matrix Partitioning and Identification

The structural stiffness and stress matrices are handled in partitioned form. The maximum size of these partitions is determined by the core storage limitations of the computer. The partition size for the stiffness matrix is 60 by 60, and the partition size of the stress matrix is 96 by 60. Each stiffness-matrix partition corresponds to ten nodes with six freedoms per node (figure 11), unless the option for specifying smaller partition sizes is used. The beam-stress matrix partitions contain ten nodes with six freedoms per node in the column



NOTE: NODE 4 TERMS ARE OMITTED FOR TRIANGULAR PLATE

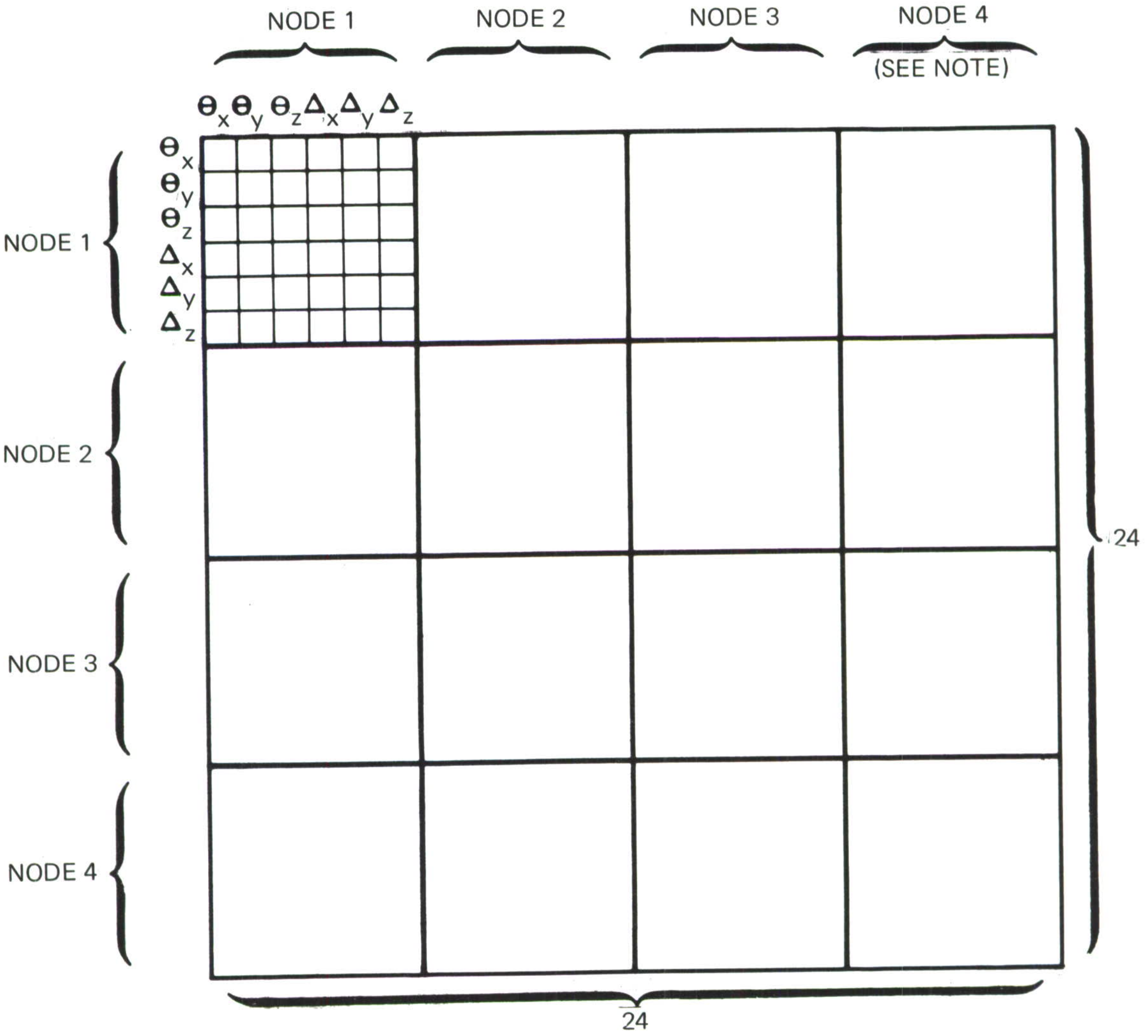
Figure 9. Elemental Plate Stress Matrix Layout

direction and eight beams with twelve stresses per beam in the row direction (figure 12). The plate-stress matrix partitions contain ten nodes in the column direction and twelve plates with eight stresses per plate in the row direction.

Each matrix partition is given a partition identification number that indicates its location in the overall matrix. The number consists of two parts: the row position and the column position (figures 11 and 12). Therefore, partition 1001 is the first partition in row 1, 1002 is the second partition of row 1, and 2001 is the first partition in row 2. Both stiffness and stress partitions are identified in this manner.

(b) Matrix Merge Procedure

The stiffness matrix is merged by partition with three partitions being merged simultaneously. The connectivity data created in the generation phase contain a list of the non-null partitions; the merge procedure is controlled by this array. The merge segment first sorts this array into ascending order of partition identification number and then begins merge by taking the first three identification numbers and merging all of the beam and plate elements that contribute to these three partitions.


NODE 1
NODE 2
NODE 3
NODE 4
(SEE NOTE)
θ_x θ_y θ_z Δ_x Δ_y Δ_z
NODE 1
θ_x
θ_y
θ_z
Δ_x
Δ_y
Δ_z
NODE 2
NODE 3
NODE 4
24
24

NOTE: ROWS AND COLUMNS FOR NODE 4 ARE OMITTED FOR TRIANGULAR PLATES YIELDING AN (18 x 18) STIFFNESS MATRIX.

Figure 10. Elemental Plate Stiffness Matrix Layout

	NODES 1-10	NODES 11-20	NODES 21-30	NODES 31-36
NODES 1-10	1001			
NODES 11-20	2001	2002		
NODES 21-30	3001	3002	3003	
NODES 31-36	4001	4002	4003	4004

Figure 11. Structural Matrix Partitioning

	NODES 1-10	NODES 11-20	NODES 21-30	NODES 31-36
ELEMENTS 1-8 FOR BEAMS OR 1-4 FOR PLATES	1001	1002	1003	1004
BEAMS 9-16 OR PLATES 5-8	2001	2002	2003	2004
BEAMS 17-24 OR PLATES 9-12	3001	3002	3003	3004

Figure 12. Merged Stress Matrix

After the merging of each group of three stiffness matrix partitions, the three partitions are sorted by applying the constraint conditions specified in the input data. The elements relating the unrestrained freedoms are sorted into the upper left-hand corner of each partition, whereas the constrained freedoms are sorted into the lower right-hand corner of the partition. The upper right-hand and lower left-hand portions of the partition contain the crosscoupling terms between the two types of freedoms (figure 13).

Only the upper left-hand portion (hereafter referred to as $[K_{ff}]$ for K-free-free) is saved on tape for later use. The other parts are discarded.

The program merges only the non-null partitions. The matrix is in lower triangular form since it is symmetrical about the diagonal.

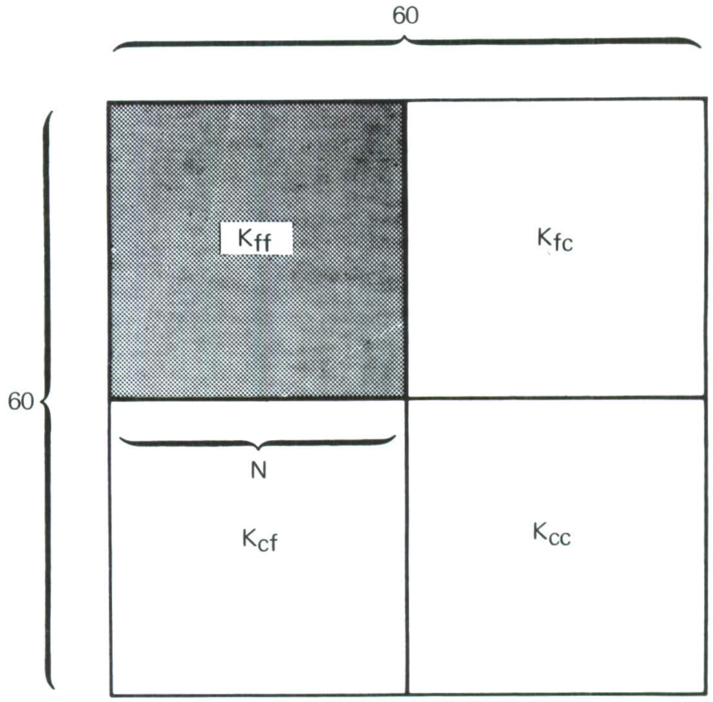
The stress matrices are merged in much the same way as the stiffness matrices with the main difference being that the stress terms do not add to each other as they do in the stiffness matrix. Again, only the non-null partitions are formed. The beam and plate stresses are merged separately, resulting in two structural stress matrices: one for beams and one for plates.

(3) Matrix Sorting and Expansion

To reduce unwanted freedoms, the $[K_{ff}]$ matrix must be sorted into four parts. The $[K_{11}]$ part relates freedoms that are to be retained. The $[K_{22}]$ part relates freedoms that are to be reduced. The $[K_{12}]$ and $[K_{21}]$ parts contain the terms of crosscoupling between the two types of freedoms. Also, since the TL01 reduction phase requires matrices in full form rather than in lower triangular, the four parts $[K_{11}]$, $[K_{12}]$, $[K_{21}]$, and $[K_{22}]$ must be expanded from lower triangular to full form.

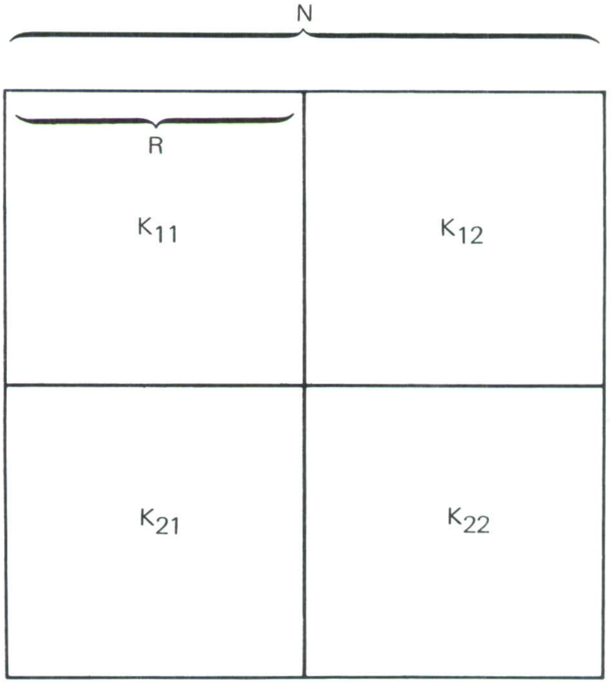
The stress matrix must be sorted into two parts in the column direction with only the first part $[S_1]$ corresponding to the $[K_{11}]$ freedoms and with the second part $[S_2]$ corresponding to the $[K_{22}]$ freedoms (figure 14).

The sorting of the $[K_{ff}]$ partitions is done one partition at a time, and the four parts are written on separate tapes. Since $[K_{ff}]$ does not contain null partitions, these must also be supplied at this time with the result being the four parts $[K_{11}]$, $[K_{12}]$, $[K_{21}]$, and $[K_{22}]$ on tapes in lower triangular form with null partitions inserted. The expansion process takes place


60
60
Kff
Kfc
N
Kcf
Kcc

NOTE: $[K_{fc}]$, $[K_{cf}]$, AND $[K_{cc}]$ TERMS ARE DELETED AND ONLY $[K_{ff}]$ IS WRITTEN ON TAPE.

(a) Merged


N
R
K11
K12
K21
K22

(b) Sorted

Figure 13. Stiffness Matrix Partitions

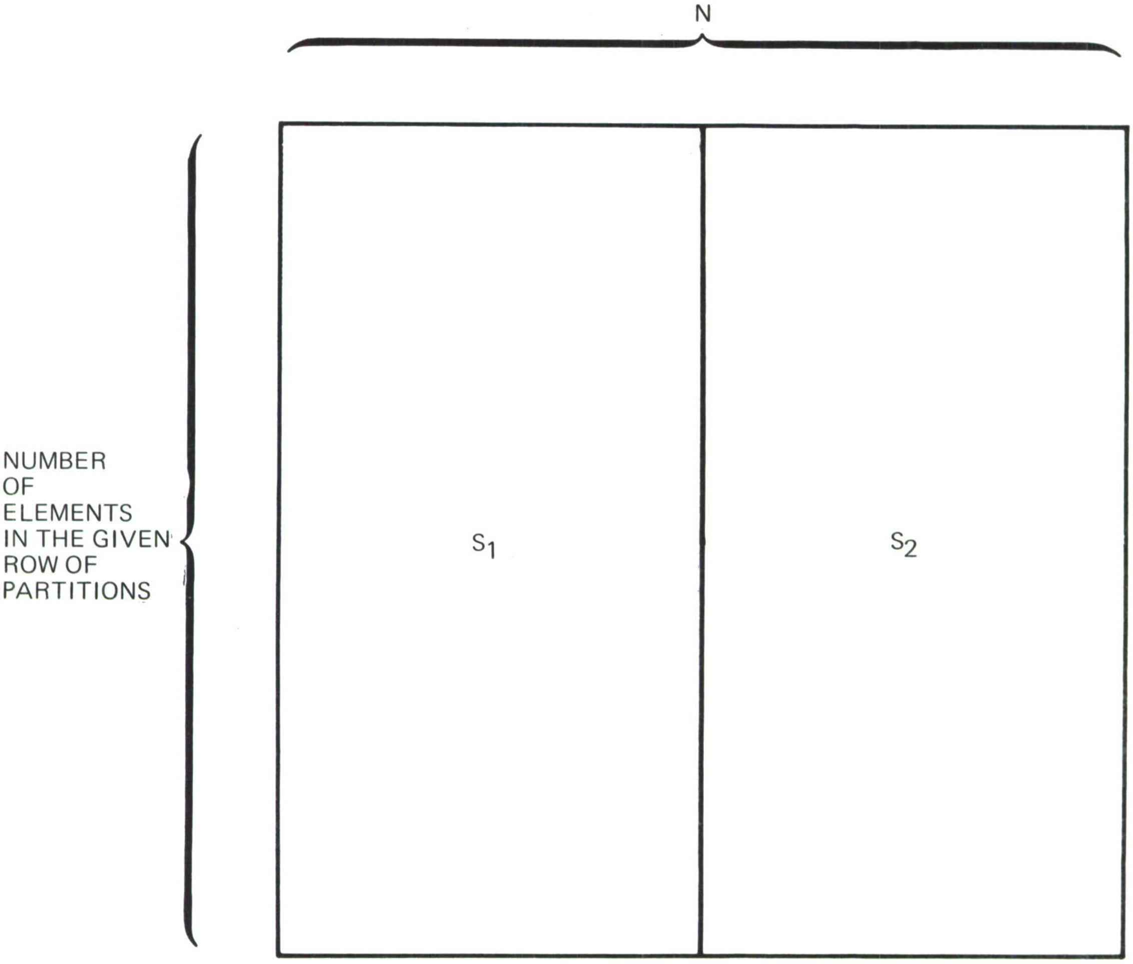

N
NUMBER OF ELEMENTS IN THE GIVEN ROW OF PARTITIONS
S_1
S_2

Figure 14. Sorted Stress Matrix Partition

next with $[K_{11}]$ and $[K_{22}]$ being expanded by the same subroutine (EXPAND). The expansion of $[K_{12}]$ and $[K_{21}]$, however, is complicated by the fact that a given partition in $[K_{ff}]$ need not have any retained freedoms. This results in $[K_{21}]$ and $[K_{12}]$ matrices that are not exactly lower triangular in form (figure 15). Therefore, a separate subroutine is required to perform the expansion of these two matrices (EXTRAN) with $[K_{21}]$ being formed first and $[K_{12}]$ then being written using the transpose of the appropriate $[K_{21}]$ partitions.

The result of this sorting and expansion is two tapes, one containing a parameter matrix in the first file (giving the number of partitions in each of the following files) and giving $[K_{11}]$ in the second file, $[K_{12}]$ in the third file, and $[K_{21}]$ in the fourth file. The $[K_{22}]$ matrix is written on a separate tape.

The stress sorting is somewhat simpler, because expansion is not required. There is, however, one complication. The stress matrices contain columns for all freedoms in the structure (both fixed and constrained). This requires that the columns representing constrained freedoms be deleted before sorting. Once this is accomplished, the two stress matrices may be sorted in a manner similar to the stiffness matrix but in the column direction only. The two parts $[S_1]$ and $[S_2]$ are written on one tape with a parameter matrix (similar to stiffness) in the first file, $[S_1]$ in the second file, and $[S_2]$ in the third file.

(4) Reduction Procedure

When the sorted stiffness and stress matrices have been written on tape in the proper form, the MAST module then calls the TL01 matrix package to form the reduced stiffness and stress matrices. The TL01 "data phases" are located on tape, and the MAST module executes them as requested by the specific program options being used (figure 16).

For general use, the program will execute data phases 1 through 3 in sequence with data phases P and B being executed only if the stress option is used. For program checkout, the reduced stiffness, reduced flexibility, and reduced stress matrices may be printed out. Refer to the listing of the MAST subroutine in paragraph 1.b. (3)(d).

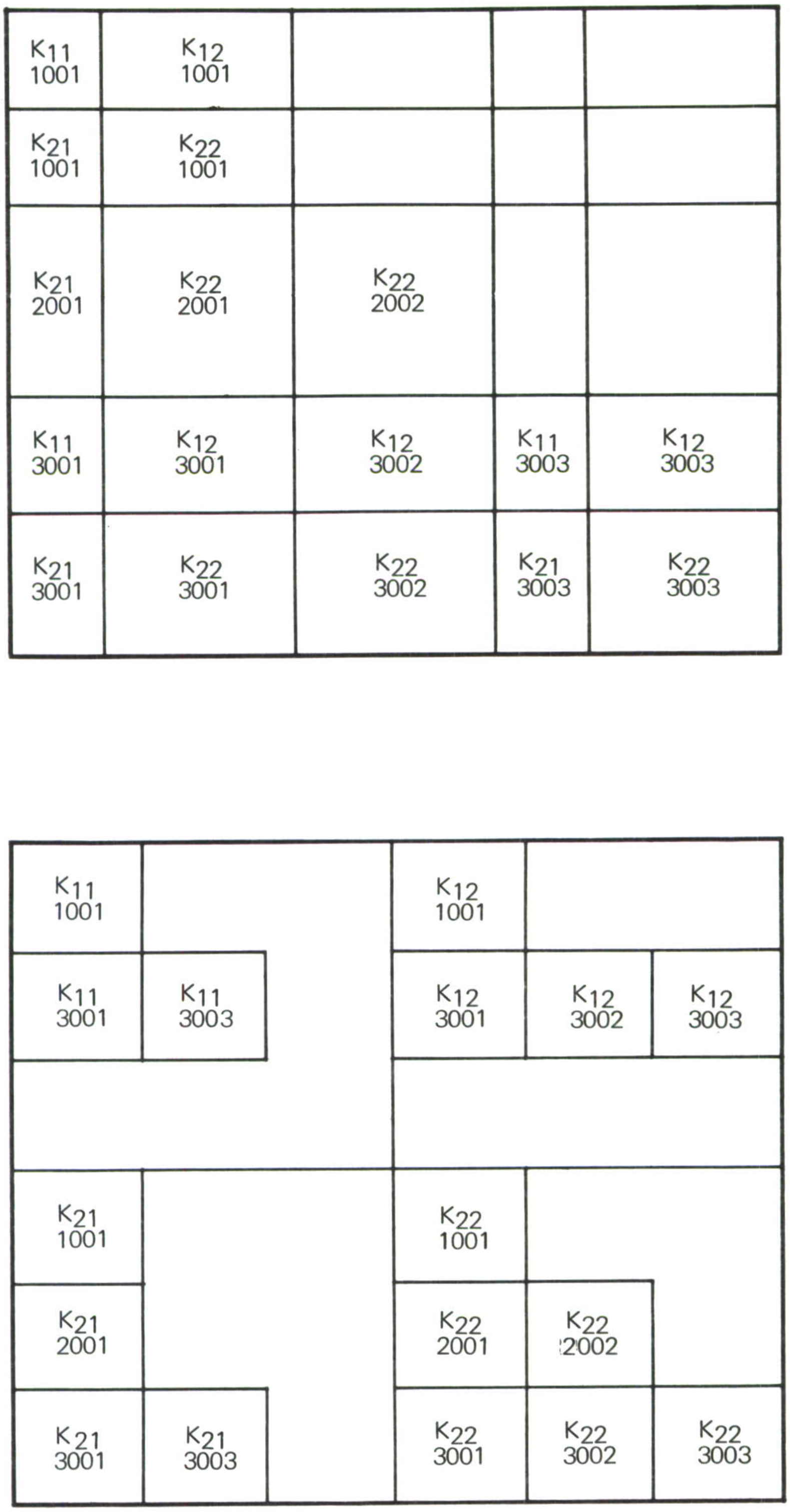
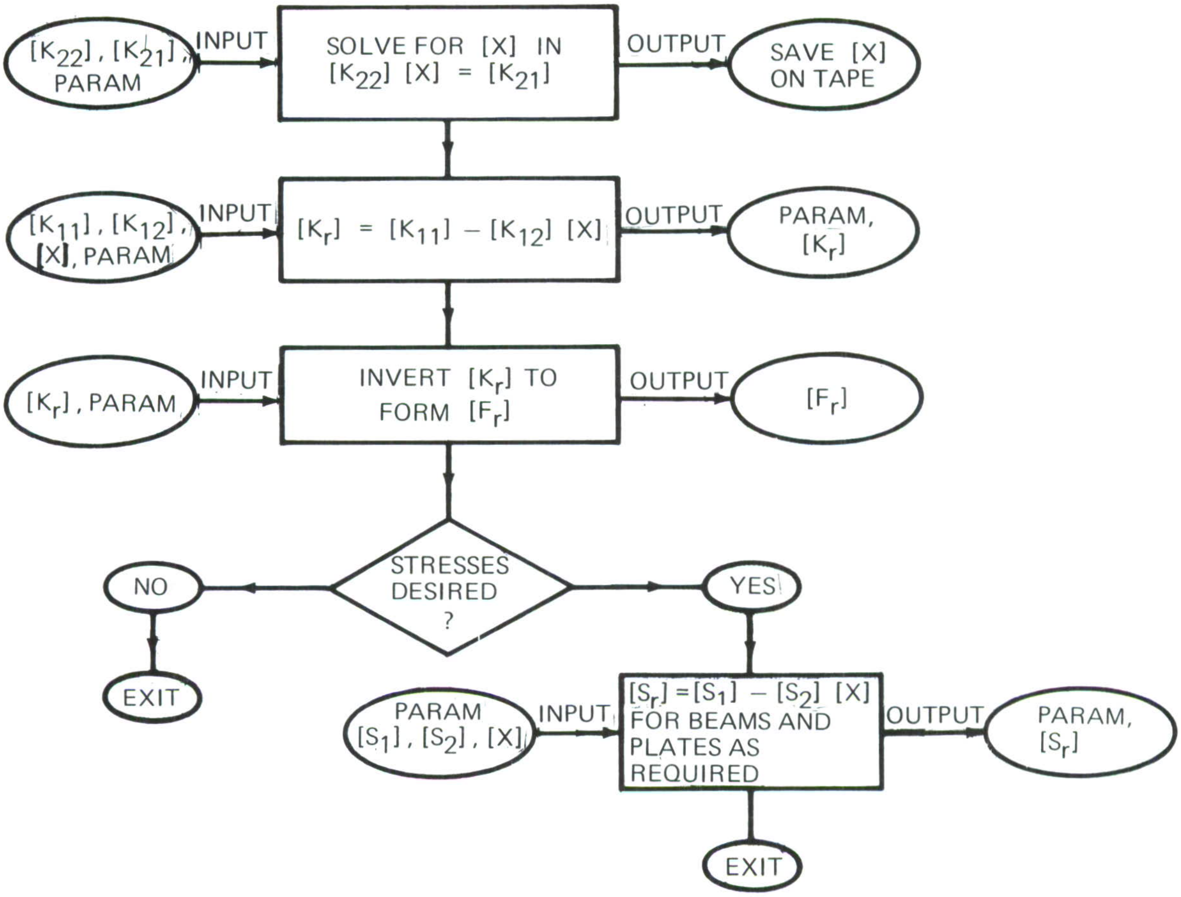

K_{11} 1001
K_{12} 1001
K_{21} 1001
K_{22} 1001
K_{21} 2001
K_{22} 2001
K_{22} 2002
K_{11} 3001
K_{12} 3001
K_{12} 3002
K_{11} 3003
K_{12} 3003
K_{21} 3001
K_{22} 3001
K_{22} 3002
K_{21} 3003
K_{22} 3003
K_{11} 1001
K_{12} 1001
K_{11} 3001
K_{11} 3003
K_{12} 3001
K_{12} 3002
K_{12} 3003
K_{21} 1001
K_{22} 1001
K_{21} 2001
K_{22} 2001
K_{22} 2002
K_{21} 3001
K_{21} 3003
K_{22} 3001
K_{22} 3002
K_{22} 3003

Figure 15. Sorted Stiffness Matrices



[K22], [K21], PARAM
INPUT
SOLVE FOR [X] IN [K22] [X] = [K21]
OUTPUT
SAVE [X] ON TAPE
[K11], [K12], [X], PARAM
INPUT
[Kr] = [K11] – [K12] [X]
OUTPUT
PARAM, [Kr]
[Kr], PARAM
INPUT
INVERT [Kr] TO FORM [Fr]
OUTPUT
[Fr]
STRESSES DESIRED ?
NO
YES
EXIT
PARAM [S1], [S2], [X]
INPUT
[Sr] = [S1] – [S2] [X] FOR BEAMS AND PLATES AS REQUIRED
OUTPUT
PARAM, [Sr]
EXIT

Figure 16. TL01 Phase Layout

c. Programming Organization

(1) Flow Diagrams

On the following pages are the overlay structure (figure 17) and flow diagrams (figure 18) for the MAST module.

(2) Tape Use

Figures 19 and 20 are the tape-use charts and tape format for the MAST module for the RANVIB system.

d. MAST Subroutine Listing

The following list identifies the MAST module subroutines and their functions. The subroutines are listed in the order they occur on the phase I master tape.

Subroutine	Function
MAST	Reads control cards and controls execution of MAST module
PAGHED	Prints page heading
UNPACK	Unpacks constraint-condition data
PRINT	Prints matrices or vectors
SUBM1	Controls generation of merge
GENRAT	Controls element generation
REDUCE	Reduces freedoms from elemental matrices
INFO	Reads in nodal data
PLATE	Reads plate data and controls
MUL1	Matrix multiplication, $[C] = [A][B]$
MUL2	Matrix multiplication, $[C] = [A]^T [B]$
PSTIF	Controls local-coordinate generation and elemental stiffness matrix generation for plates
QUAD	Controls elemental stiffness generation for quadrilateral plates
LAMK	Performs coordinate transformation from local-stiffness to structural stiffness matrices

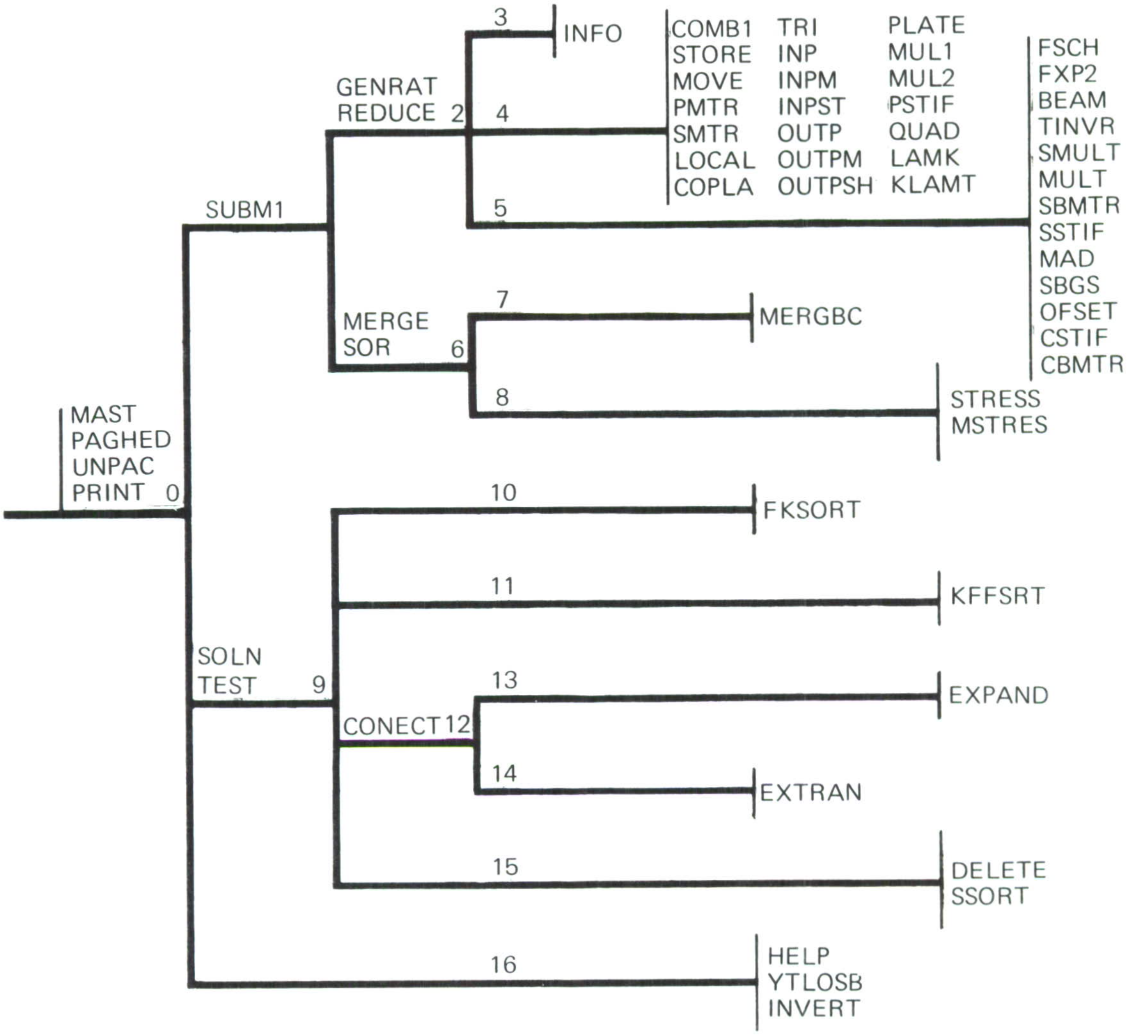

3
INFO
COMB1
STORE
MOVE
PMTR
SMTR
LOCAL
COPLA
TRI
INP
INPM
INPST
OUTP
OUTPM
OUTPSH
PLATE
MUL1
MUL2
PSTIF
QUAD
LAMK
KLAMT
FSCH
FXP2
BEAM
TINVR
SMULT
MULT
SBMTR
SSTIF
MAD
SBGS
OFSET
CSTIF
CBMTR
GENRAT
REDUCE 2
4
5
SUBM1
MERGE
SOR 6
7
MERGBC
8
STRESS
MSTRES
MAST
PAGHED
UNPAC
PRINT 0
10
FKSORT
11
KFFSRT
SOLN
TEST 9
13
EXPAND
CONECT 12
14
EXTRAN
15
DELETE
SSORT
16
HELP
YTLOSB
INVERT

Figure 17. Mast Overlay Structure

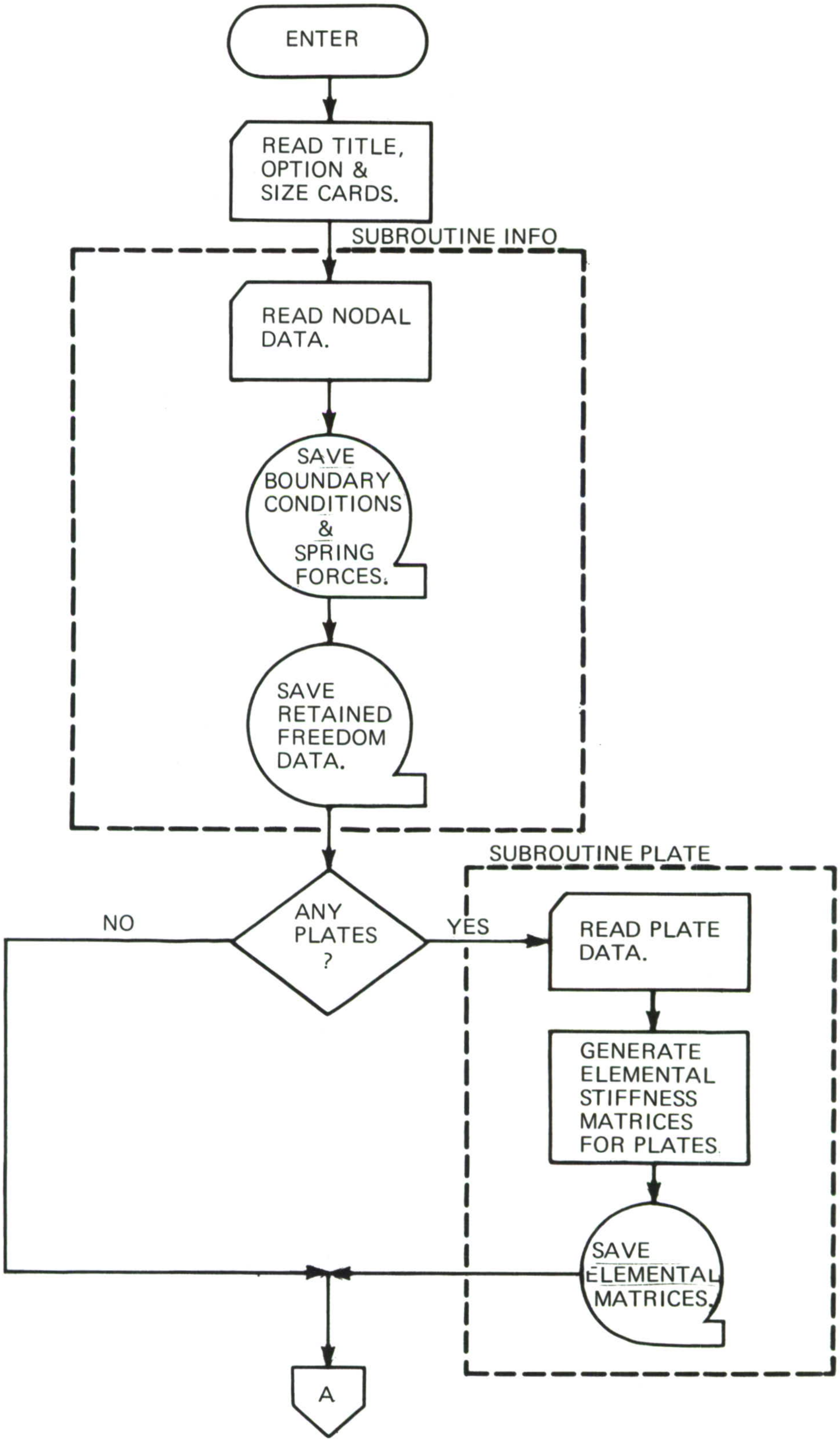

ENTER
READ TITLE, OPTION & SIZE CARDS.
SUBROUTINE INFO
READ NODAL DATA.
SAVE BOUNDARY CONDITIONS & SPRING FORCES.
SAVE RETAINED FREEDOM DATA.
SUBROUTINE PLATE
ANY PLATES ?
NO
YES
READ PLATE DATA.
GENERATE ELEMENTAL STIFFNESS MATRICES FOR PLATES.
SAVE ELEMENTAL MATRICES.
A

Figure 18. MAST Flow Chart

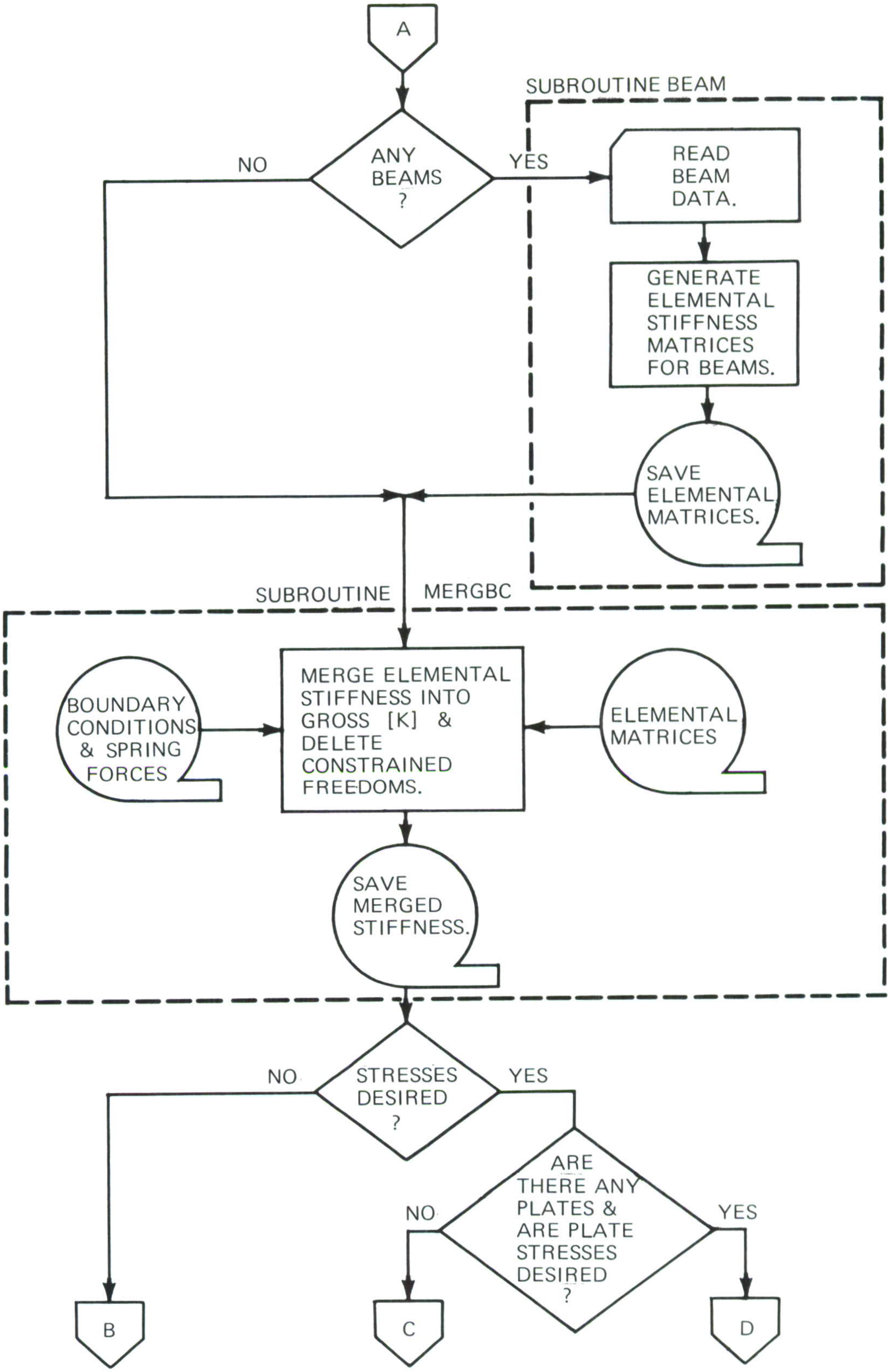

A
SUBROUTINE BEAM
NO
ANY BEAMS ?
YES
READ BEAM DATA.
GENERATE ELEMENTAL STIFFNESS MATRICES FOR BEAMS.
SAVE ELEMENTAL MATRICES.
SUBROUTINE MERGBC
BOUNDARY CONDITIONS & SPRING FORCES
MERGE ELEMENTAL STIFFNESS INTO GROSS [K] & DELETE CONSTRAINED FREEDOMS.
ELEMENTAL MATRICES
SAVE MERGED STIFFNESS.
NO
STRESSES DESIRED ?
YES
ARE THERE ANY PLATES & ARE PLATE STRESSES DESIRED ?
NO
YES
B
C
D

Figure 18.—Continued

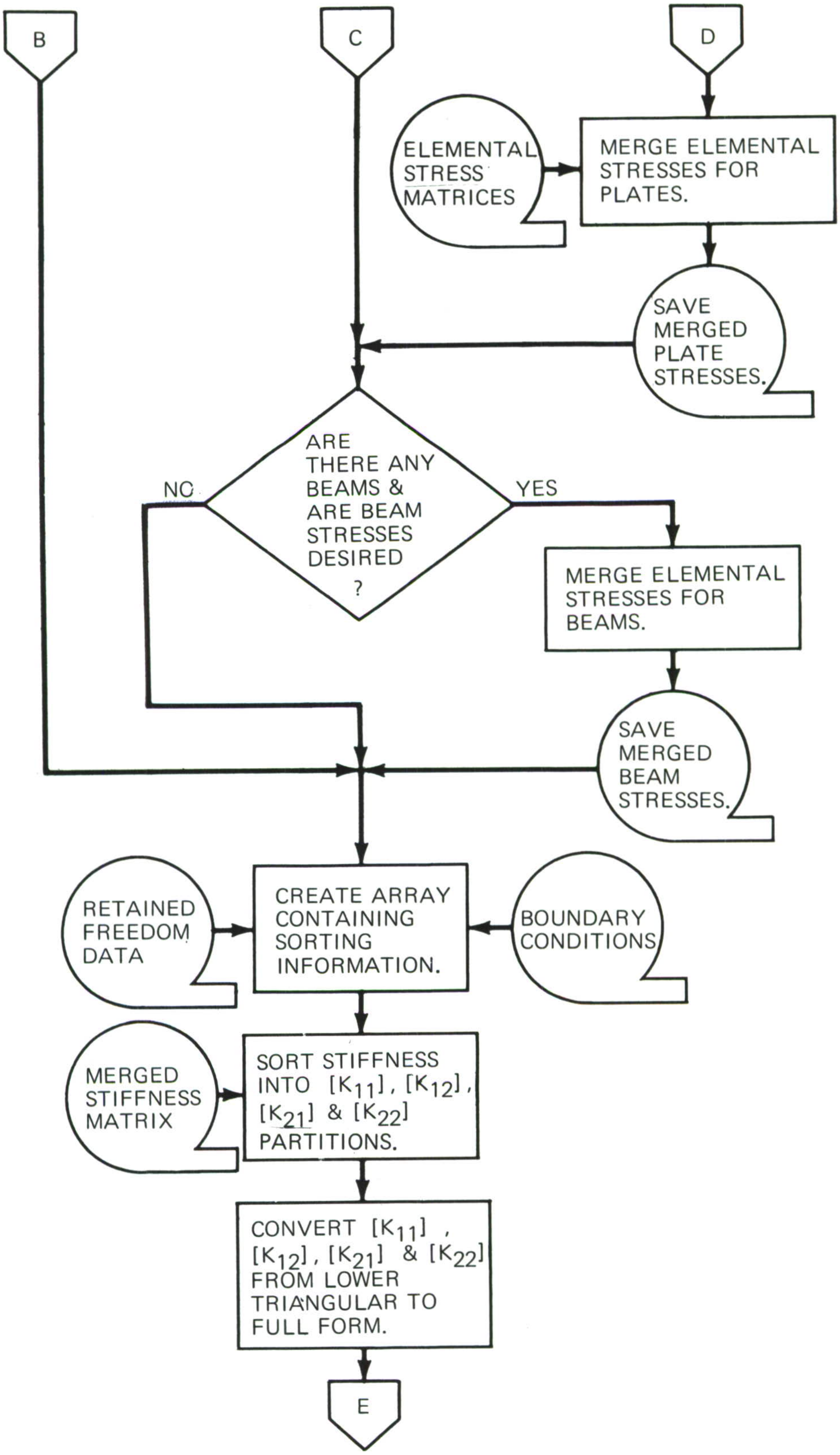

B
C
D
ELEMENTAL STRESS MATRICES
MERGE ELEMENTAL STRESSES FOR PLATES.
SAVE MERGED PLATE STRESSES.
ARE THERE ANY BEAMS & ARE BEAM STRESSES DESIRED ?
NO
YES
MERGE ELEMENTAL STRESSES FOR BEAMS.
SAVE MERGED BEAM STRESSES.
RETAINED FREEDOM DATA
CREATE ARRAY CONTAINING SORTING INFORMATION.
BOUNDARY CONDITIONS
MERGED STIFFNESS MATRIX
SORT STIFFNESS INTO [K11], [K12], [K21] & [K22] PARTITIONS.
CONVERT [K11], [K12], [K21] & [K22] FROM LOWER TRIANGULAR TO FULL FORM.
E

Figure 18—Continued

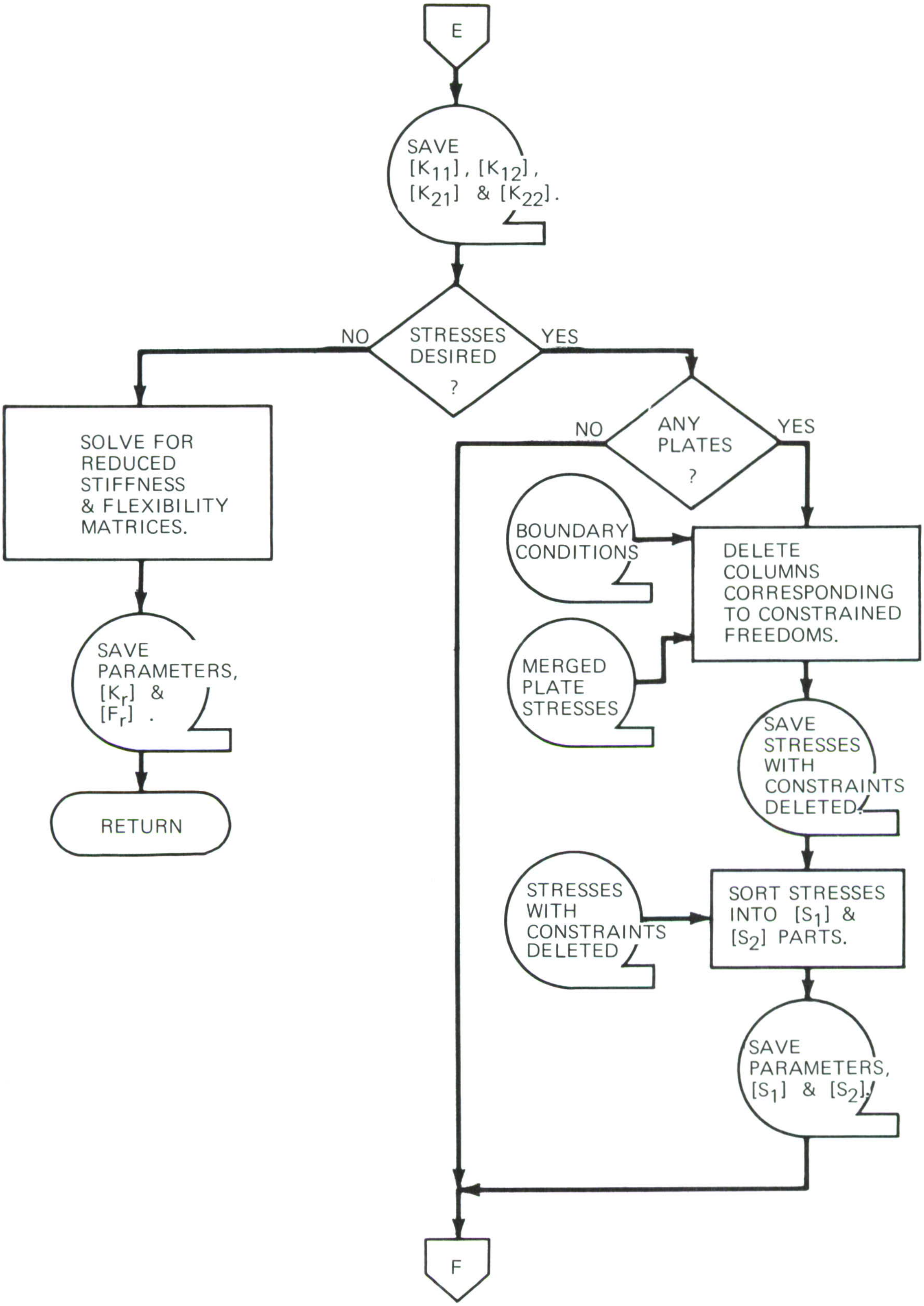

E
SAVE
$[K_{11}]$, $[K_{12}]$,
$[K_{21}]$ & $[K_{22}]$.
NO
STRESSES DESIRED ?
YES
SOLVE FOR REDUCED STIFFNESS & FLEXIBILITY MATRICES.
SAVE PARAMETERS, $[K_r]$ & $[F_r]$.
RETURN
NO
ANY PLATES ?
YES
BOUNDARY CONDITIONS
MERGED PLATE STRESSES
DELETE COLUMNS CORRESPONDING TO CONSTRAINED FREEDOMS.
SAVE STRESSES WITH CONSTRAINTS DELETED.
STRESSES WITH CONSTRAINTS DELETED
SORT STRESSES INTO $[S_1]$ & $[S_2]$ PARTS.
SAVE PARAMETERS, $[S_1]$ & $[S_2]$.
F

Figure 18—Continued

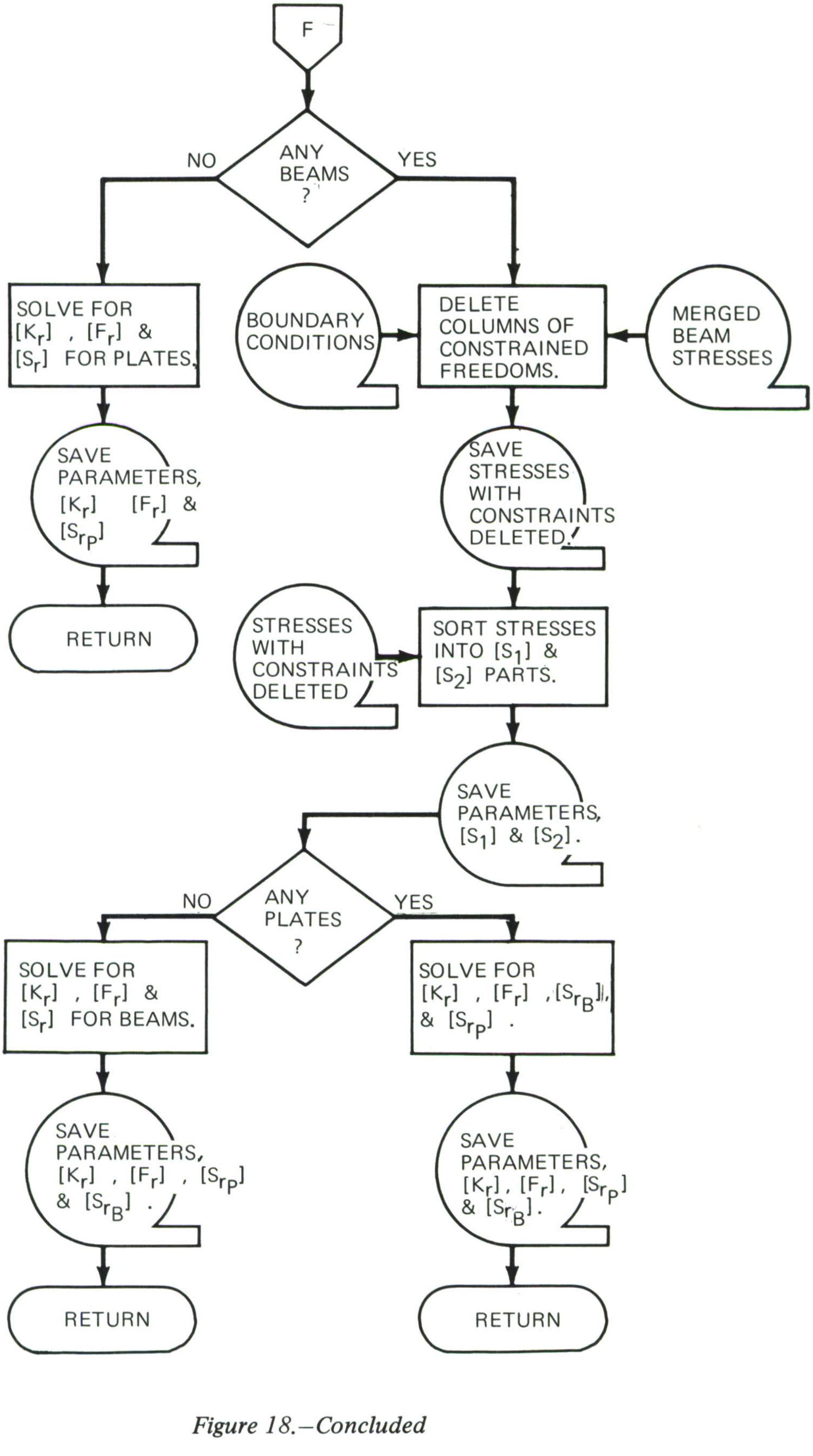

F
ANY BEAMS ?
NO
YES
SOLVE FOR [K_r], [F_r] & [S_r] FOR PLATES.
SAVE PARAMETERS, [K_r] [F_r] & [S_{rP}]
RETURN
BOUNDARY CONDITIONS
DELETE COLUMNS OF CONSTRAINED FREEDOMS.
MERGED BEAM STRESSES
SAVE STRESSES WITH CONSTRAINTS DELETED.
STRESSES WITH CONSTRAINTS DELETED
SORT STRESSES INTO [S_1] & [S_2] PARTS.
SAVE PARAMETERS, [S_1] & [S_2].
ANY PLATES ?
NO
YES
SOLVE FOR [K_r], [F_r] & [S_r] FOR BEAMS.
SOLVE FOR [K_r], [F_r], [S_{rB}], & [S_{rP}].
SAVE PARAMETERS, [K_r], [F_r], [S_{rP}] & [S_{rB}].
SAVE PARAMETERS, [K_r], [F_r], [S_{rP}] & [S_{rB}].
RETURN
RETURN

Figure 18.–Concluded

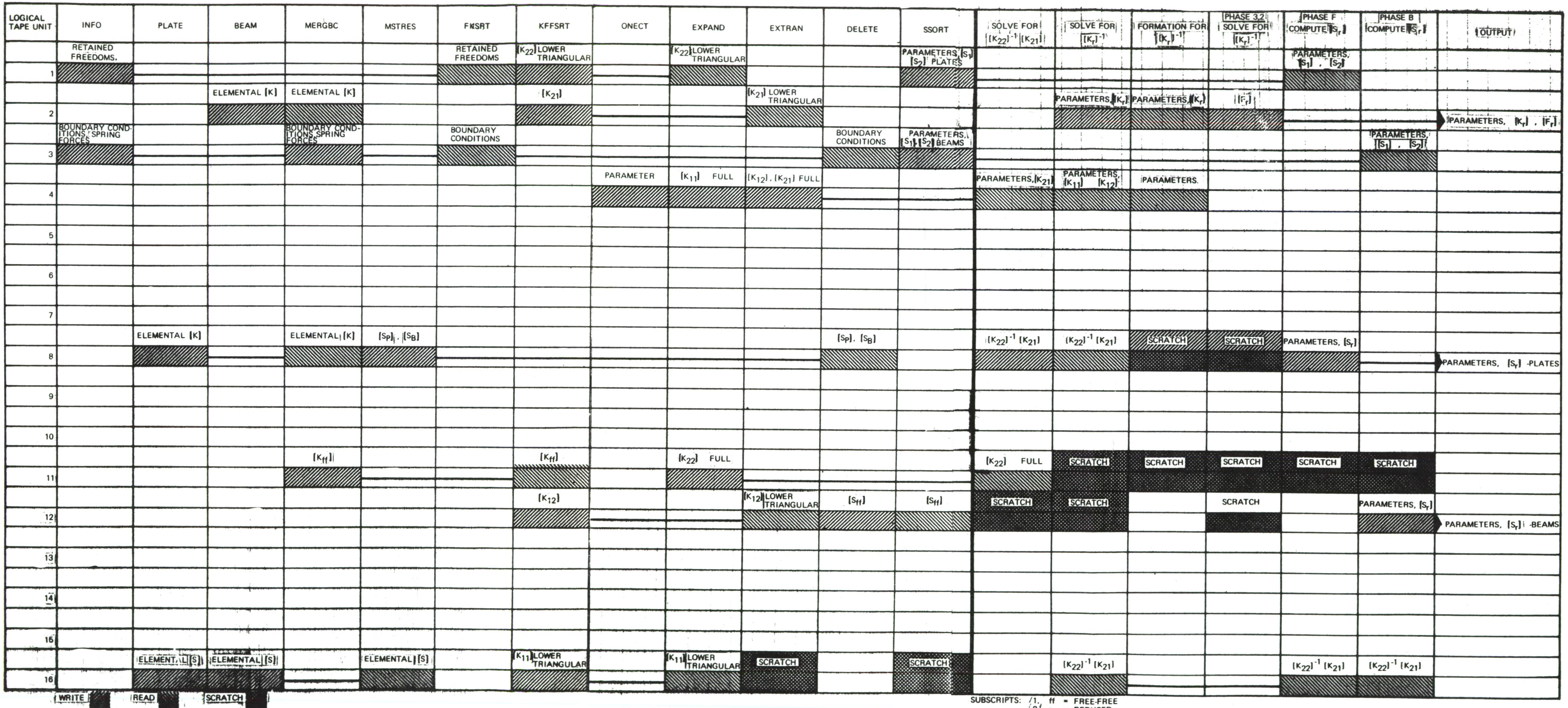

LOGICAL TAPE UNIT
INFO
PLATE
BEAM
MERGBC
MSTRES
FKSRT
KFFSRT
ONECT
EXPAND
EXTRAN
DELETE
SSORT
SOLVE FOR $[K_{22}]^{-1}[K_{21}]$
SOLVE FOR $[K_r]^{-1}$
FORMATION FOR $[K_r]^{-1}$
PHASE 3.2 SOLVE FOR $[K_r]^{-1}$
PHASE F COMPUTE $[S_r]$
PHASE B COMPUTE $[S_r]$
OUTPUT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
RETAINED FREEDOMS.
RETAINED FREEDOMS
$[K_{22}]$ LOWER TRIANGULAR
$[K_{22}]$ LOWER TRIANGULAR
PARAMETERS, $[S_1]$ $[S_2]$ PLATES
PARAMETERS, $[S_1]$, $[S_2]$
ELEMENTAL [K]
ELEMENTAL [K]
$[K_{21}]$
$[K_{21}]$ LOWER TRIANGULAR
PARAMETERS, $[K_r]$
PARAMETERS, $[K_r]$
$[F_r]$
PARAMETERS, $[K_r]$, $[F_r]$
BOUNDARY CONDITIONS, SPRING FORCES
BOUNDARY CONDITIONS, SPRING FORCES
BOUNDARY CONDITIONS
BOUNDARY CONDITIONS
PARAMETERS, $[S_1]$, $[S_2]$ BEAMS
PARAMETERS, $[S_1]$, $[S_2]$
PARAMETER
$[K_{11}]$ FULL
$[K_{12}]$, $[K_{21}]$ FULL
PARAMETERS, $[K_{21}]$
PARAMETERS, $[K_{11}]$ $[K_{12}]$
PARAMETERS.
ELEMENTAL [K]
ELEMENTAL [K]
$[S_P]$, $[S_B]$
$[S_P]$, $[S_B]$
$[K_{22}]^{-1}[K_{21}]$
$[K_{22}]^{-1}[K_{21}]$
SCRATCH
SCRATCH
PARAMETERS, $[S_r]$
PARAMETERS, $[S_r]$ -PLATES
$[K_{ff}]$
$[K_{ff}]$
$[K_{22}]$ FULL
$[K_{22}]$ FULL
SCRATCH
SCRATCH
SCRATCH
SCRATCH
SCRATCH
$[K_{12}]$
$[K_{12}]$ LOWER TRIANGULAR
$[S_{ff}]$
$[S_{ff}]$
SCRATCH
SCRATCH
SCRATCH
PARAMETERS, $[S_r]$
PARAMETERS, $[S_r]$ -BEAMS
ELEMENTAL [S]
ELEMENTAL [S]
ELEMENTAL [S]
$[K_{11}]$ LOWER TRIANGULAR
$[K_{11}]$ LOWER TRIANGULAR
SCRATCH
SCRATCH
$[K_{22}]^{-1}[K_{21}]$
$[K_{22}]^{-1}[K_{21}]$
$[K_{22}]^{-1}[K_{21}]$
WRITE
READ
SCRATCH
SUBSCRIPTS: 1. ff = FREE-FREE
2. r = REDUCED
3. B = BEAMS
4. P = PLATES

Figure 19. MAST Subroutine Tape Use Chart

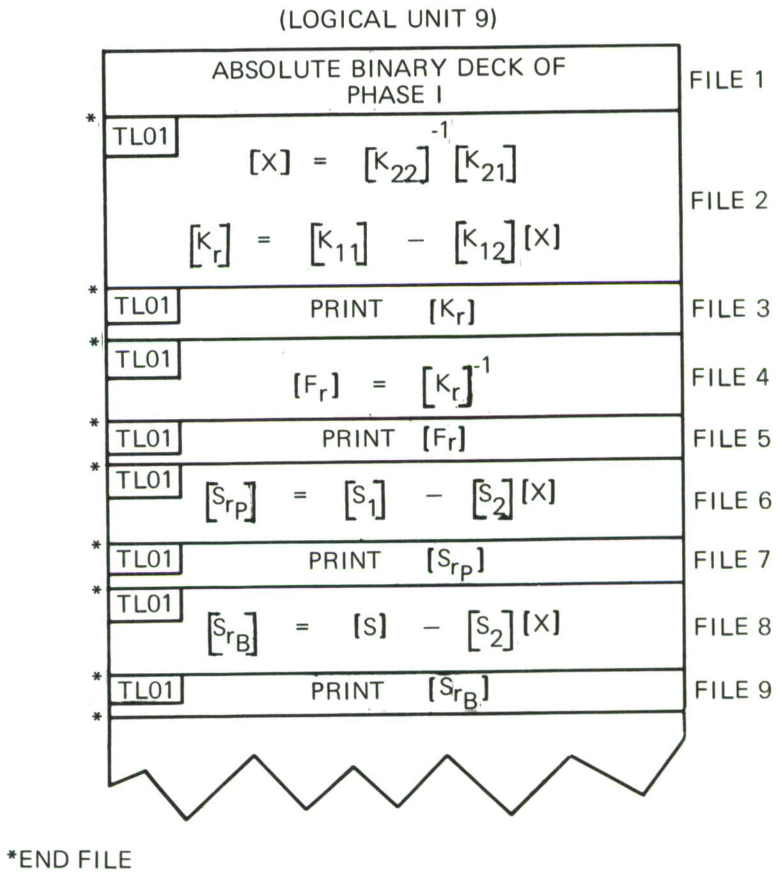

(LOGICAL UNIT 9)
ABSOLUTE BINARY DECK OF PHASE I
FILE 1
TL01
$[X] = [K_{22}]^{-1} [K_{21}]$
$[K_r] = [K_{11}] - [K_{12}][X]$
FILE 2
TL01
PRINT $[K_r]$
FILE 3
TL01
$[F_r] = [K_r]^{-1}$
FILE 4
TL01
PRINT $[F_r]$
FILE 5
TL01
$[S_{r_P}] = [S_1] - [S_2][X]$
FILE 6
TL01
PRINT $[S_{r_P}]$
FILE 7
TL01
$[S_{r_B}] = [S] - [S_2][X]$
FILE 8
TL01
PRINT $[S_{r_B}]$
FILE 9
*END FILE

Figure 20. Phase I Master Tape Detail

Subroutine	Function
KLAMT	Performs coordinate transformation from local-stiffness to structural stiffness matrices
TRI	Controls generation of elemental stiffness matrices for triangular plates
INP	Controls generation of in-plane plate stiffness terms
INPM	Generates in-plane moment plate terms
INPST	Generates in-plane plate stretching terms
OUTP	Controls generation of out-of-plane plate stiffness terms
OUTPM	Generates out-of-plane plate moment terms
OUTPSH	Generates out-of-plane plate shear terms
COMBIN	Combines in-plane terms or out-of-plane terms
STORE	Stores in-plane and out-of-plane terms in elemental stiffness matrix
MOVE	Matrix addition, $[B] = [A] + [B]$
PMTR	Generates coordinate-transformation matrix for triangular or quadrilateral plates
SMTR	Generates stress-transformation matrix for triangular or quadrilateral plates
LOCAL	Generates local coordinates for plates and checks for reentrant corner and node sequencing
COPLAN	Checks quadrilateral plates for coplanarity
BEAM	Reads beam data and controls the generation of beam-element stiffness matrices
TINVR	Inverts beam flexibility matrix to get beam stiffness
SMULT	Matrix multiplication-subtraction, $[C] = [C] - [A][B]$
MULT	Matrix multiplication-addition, $[C] = [C] + [A][B]$ or $[C] = [C][A]^T[B]$ or may store results in $[B]$

Subroutine	Function
SBMTR	Generates transformation matrix for straight beams
SSTIF	Generates stiffness matrix for straight beams
MAD	Matrix addition for 12 by 12 only, $[A] = [A] + [B]$
SBGS	Generates geometric stiffness matrices for straight beams
OFST	Generates offset-transformation matrix for beams
CSTIF	Generates elemental stiffness matrix for curved beam
CBMTR	Generates transformation matrix for curved beams
MERGE	Controls merge of structural stiffness and stress matrices
SOR	Sorts the partition identification number list prior to merge of stiffness
MERGBC	Merges the structural stiffness matrix
STRESS	Controls merge of the structural stress matrices
MSTRES	Merges the structural stress matrices
SOLN	Controls the sorting of the structural stiffness and stress matrices
TEST	Tests the list of partition identifications to determine if a given partition number is present
FKSORT	Creates the control array used to sort the stiffness and stress matrices
KFFSRT	Sorts the structural stiffness matrix into retained and reduced freedoms
CONECT	Controls the expansion of the sorted stiffness matrix into full form
EXPAND	Expands the $[K_{11}]$ and $[K_{22}]$ matrices into full form
EXTRAN	Expands the $[K_{12}]$ and $[K_{21}]$ matrices into full form
DELETE	Deletes the columns of constrained freedoms from the structural stress matrices

Subroutine	Function
SSORT	Sorts the structural stress matrices into retained and reduced parts
DATA PHASE I	Solves the equation $[K_{22}]\,[X] = [K_{21}]$
DATA PHASE II	Calculates $[K_r] = [K_{11}] - [K_{12}]\,[X]$
DATA PHASE III	Calculates $[S_r] = [S_1] - [S_2]\,[X]$ (beams)
DATA PHASE IV	Calculates $[S_r] = [S_1] - [S_2]\,[X]$ (plates)

2. INTERMEDIATE MATRIX MERGE

The stiffness and flexibility matrices are merged in AMERGE to an N-by-N matrix from the partitioned matrices output on tape from the MAST module.

The stresses are merged and re-partitioned in SMERGE to 8-by-8 matrices for plates and 6-by-6 matrices for beams.

The merged flexibility matrix is used in the FREMOD module. The stiffness matrix is only used when a phase II option 1 solution is desired. The partitioned stresses are used when the stresses in phase II are wanted.

a. Subroutine AMERGE (ITAPE, NTAPE, NF1)

This subroutine merges the stiffness [K] or flexibility [F] matrices.

Method:	The matrices [K] or [F] that are formed in subroutine MAST and stored in row-partitioned form are merged to form a N-by-N matrix and stored on phase I output tape.
Input:	Stiffness/flexibility matrix on tape 2
Output:	Merged stiffness/flexibility matrix on tape 10
Error:	READTP/WRTETP error messages
Subroutines required:	READTP/WRTETP
Argument list:	ITAPE—Input tape of stiffness/flexibility NTAPE—Output tape of stiffness/flexibility NF1—Number of file marks to skip past before reading starts. NF1 = 1 for the stiffness matrix and NF1 = 2 for the flexibility matrix.

Length: 33215_8

Flow chart: See figure 21.

b. Subroutine SMERGE

Method: This subroutine merges the stresses from the MAST subroutine and re-partitions and stores the matrices on the phase I output tape. The stresses for plates and beams are re-partitioned to 8-by-8 and 6-by-6 matrices, respectively.

Input: Parameter matrix and stress matrices for plates and beams from ITAPE

Output: The re-partitioned stress matrices are stored on NTAPE. The matrices for plates are stored first, then the beam stresses are stored. Either or both stresses may be stored on tape.

Error: READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Argument list:

ITAPE—Input stress matrices are on this tape.

NTAPE—Output of the re-partitioned stress matrices are stored on this tape.

ITEST—This variable is set to 8 if the plate stresses are to be re-partitioned; 6 if the beam stresses are to be re-partitioned.

Length: 40472_8

Flow chart: See figure 22.

3. VIBRATION PROGRAM (FREMOD)

a. General Description

The purpose of the FREMOD module is to calculate the natural frequencies and normal mode shapes, given the flexibility matrix and mass matrix. This is done by solving the dynamic matrix for eigenvalues and eigenvectors using the QR algorithm.

See the macro flow chart (figure 23) and organization chart (figure 24).

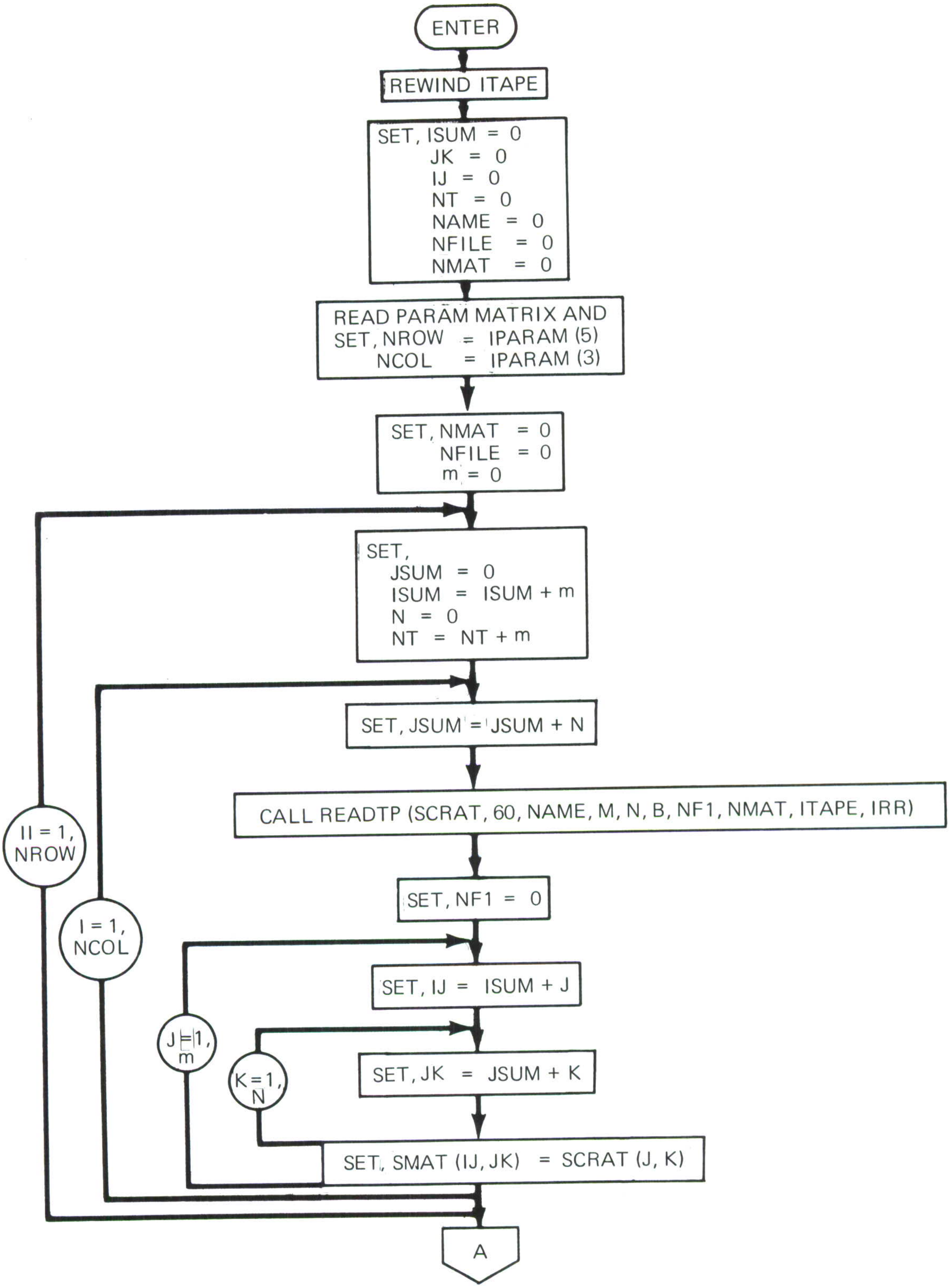

ENTER
REWIND ITAPE
SET, ISUM = 0
JK = 0
IJ = 0
NT = 0
NAME = 0
NFILE = 0
NMAT = 0
READ PARAM MATRIX AND
SET, NROW = IPARAM (5)
NCOL = IPARAM (3)
SET, NMAT = 0
NFILE = 0
m = 0
SET,
JSUM = 0
ISUM = ISUM + m
N = 0
NT = NT + m
SET, JSUM = JSUM + N
CALL READTP (SCRAT, 60, NAME, M, N, B, NF1, NMAT, ITAPE, IRR)
SET, NF1 = 0
SET, IJ = ISUM + J
SET, JK = JSUM + K
SET, SMAT (IJ, JK) = SCRAT (J, K)
II = 1, NROW
I = 1, NCOL
J = 1, m
K = 1, N
A

Figure 21. AMERGE Flow Chart

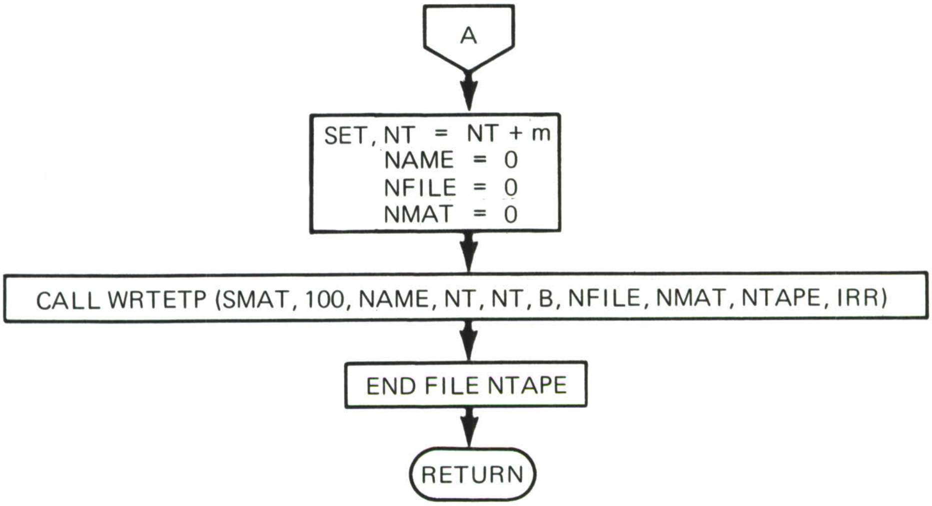

A
SET, NT = NT + m
NAME = 0
NFILE = 0
NMAT = 0
CALL WRTETP (SMAT, 100, NAME, NT, NT, B, NFILE, NMAT, NTAPE, IRR)
END FILE NTAPE
RETURN

Figure 21–Concluded

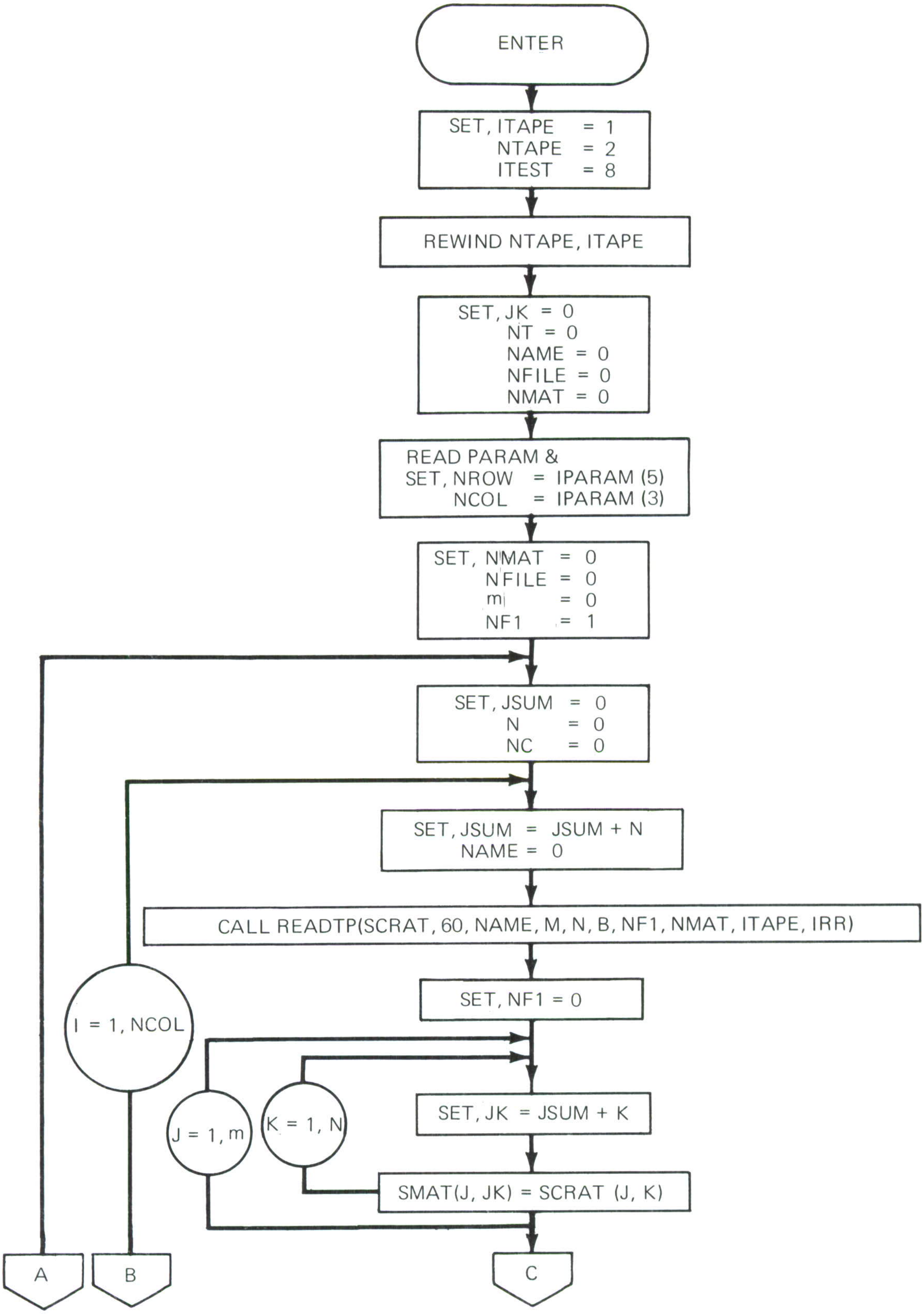

ENTER
SET, ITAPE = 1
NTAPE = 2
ITEST = 8
REWIND NTAPE, ITAPE
SET, JK = 0
NT = 0
NAME = 0
NFILE = 0
NMAT = 0
READ PARAM &
SET, NROW = IPARAM (5)
NCOL = IPARAM (3)
SET, NMAT = 0
NFILE = 0
m = 0
NF1 = 1
SET, JSUM = 0
N = 0
NC = 0
SET, JSUM = JSUM + N
NAME = 0
CALL READTP(SCRAT, 60, NAME, M, N, B, NF1, NMAT, ITAPE, IRR)
SET, NF1 = 0
I = 1, NCOL
J = 1, m
K = 1, N
SET, JK = JSUM + K
SMAT(J, JK) = SCRAT (J, K)
A
B
C

Figure 22. SMERGE Flow Chart

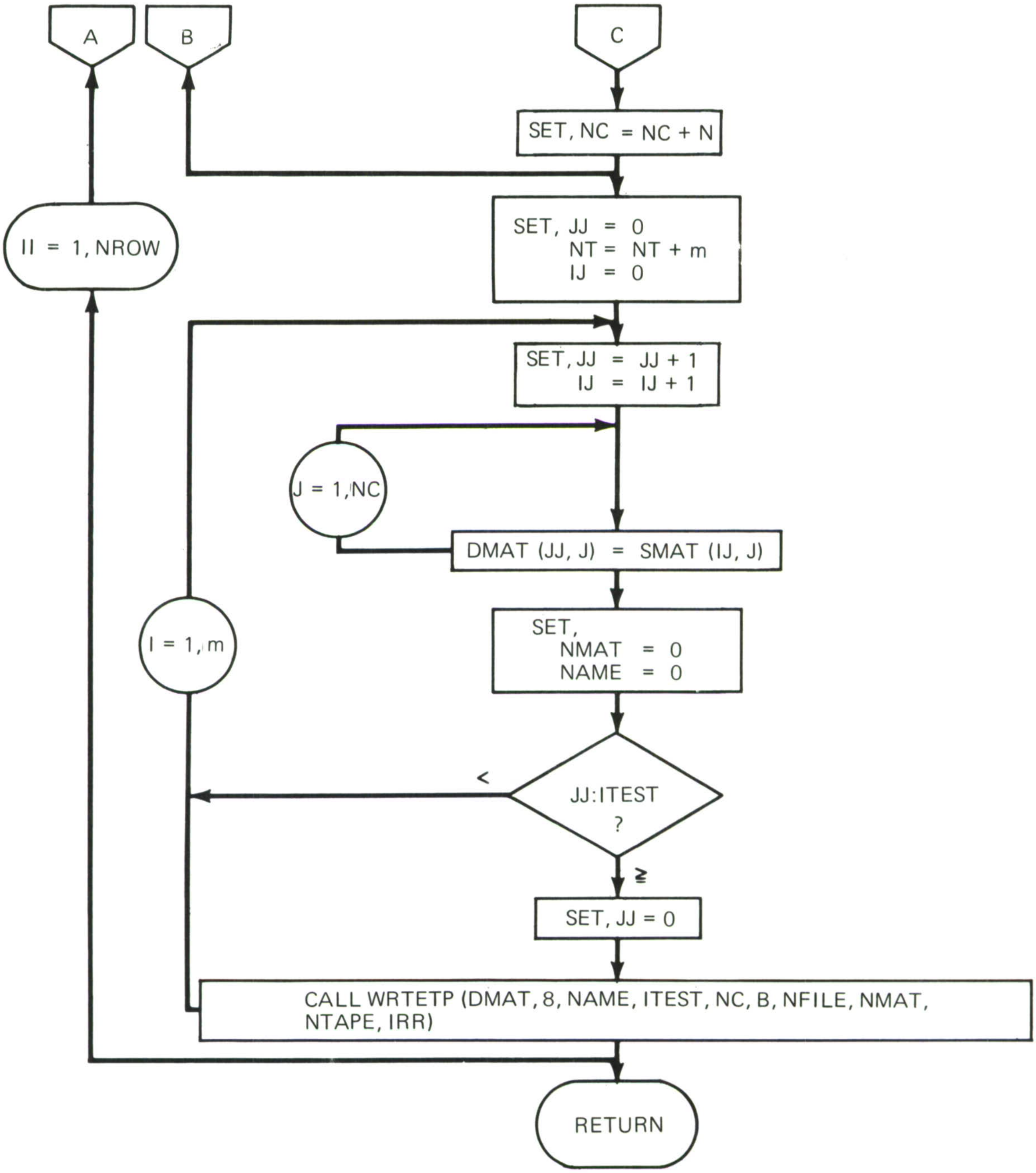

A
B
C
SET, NC = NC + N
II = 1, NROW
SET, JJ = 0
NT = NT + m
IJ = 0
SET, JJ = JJ + 1
IJ = IJ + 1
J = 1, NC
DMAT (JJ, J) = SMAT (IJ, J)
I = 1, m
SET,
NMAT = 0
NAME = 0
<
JJ:ITEST
?
≧
SET, JJ = 0
CALL WRTETP (DMAT, 8, NAME, ITEST, NC, B, NFILE, NMAT, NTAPE, IRR)
RETURN

Figure 22—Concluded

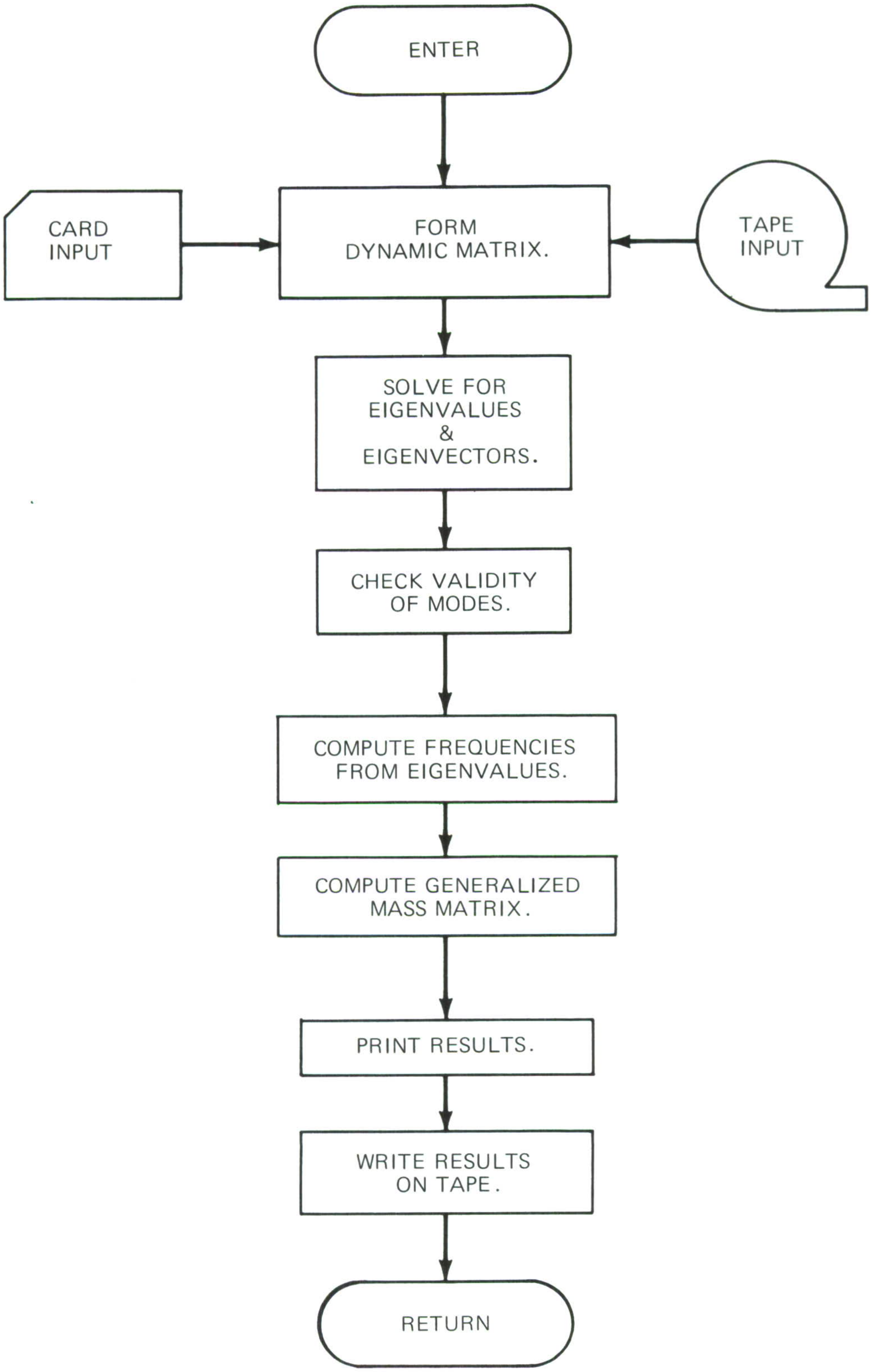

ENTER
CARD INPUT
FORM DYNAMIC MATRIX.
TAPE INPUT
SOLVE FOR EIGENVALUES & EIGENVECTORS.
CHECK VALIDITY OF MODES.
COMPUTE FREQUENCIES FROM EIGENVALUES.
COMPUTE GENERALIZED MASS MATRIX.
PRINT RESULTS.
WRITE RESULTS ON TAPE.
RETURN

Figure 23. FREMOD Macro Flow Chart

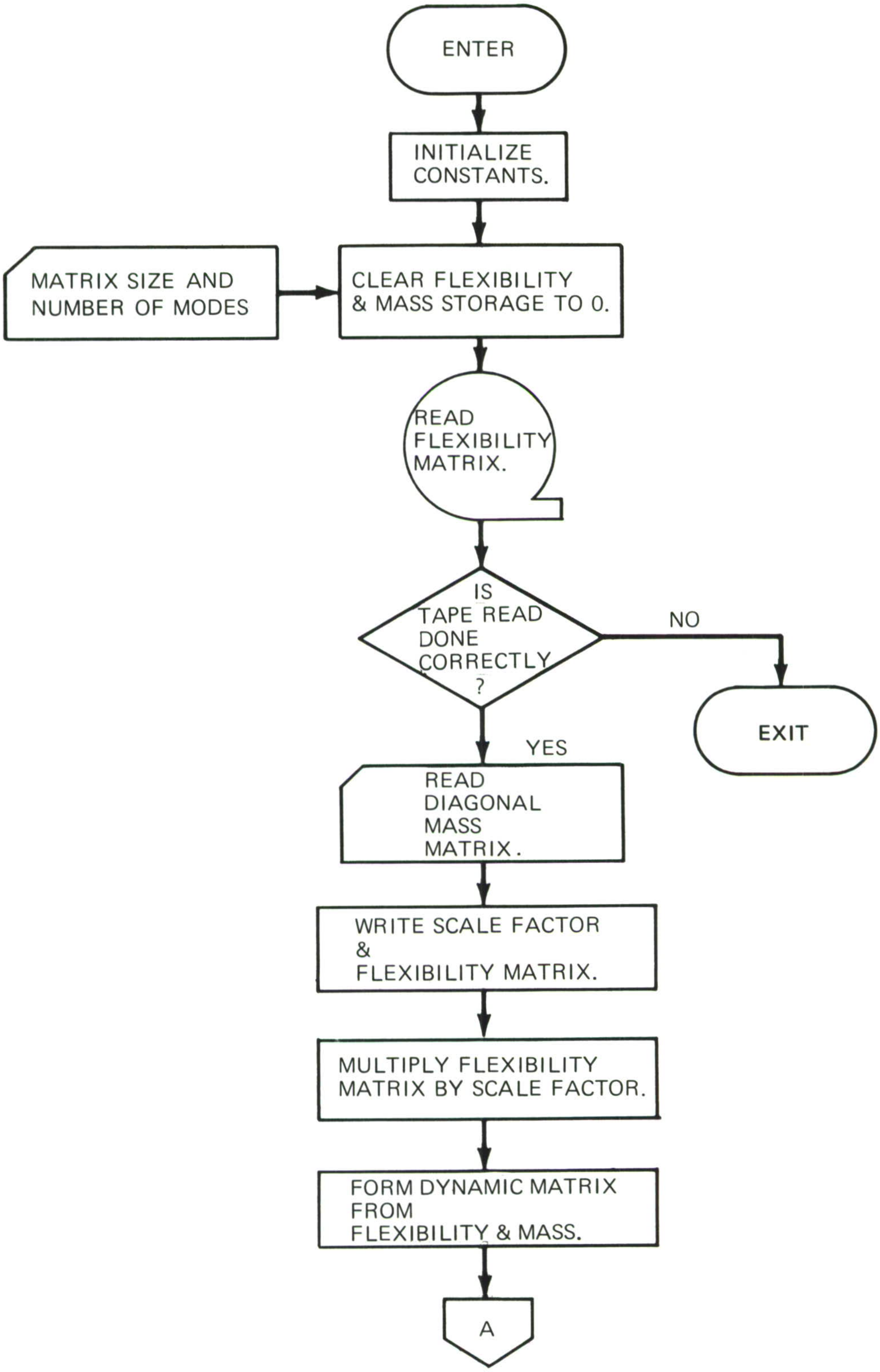

ENTER
INITIALIZE CONSTANTS.
MATRIX SIZE AND NUMBER OF MODES
CLEAR FLEXIBILITY & MASS STORAGE TO 0.
READ FLEXIBILITY MATRIX.
IS TAPE READ DONE CORRECTLY ?
NO
EXIT
YES
READ DIAGONAL MASS MATRIX.
WRITE SCALE FACTOR & FLEXIBILITY MATRIX.
MULTIPLY FLEXIBILITY MATRIX BY SCALE FACTOR.
FORM DYNAMIC MATRIX FROM FLEXIBILITY & MASS.
A

Figure 24. FREMOD Program Organization

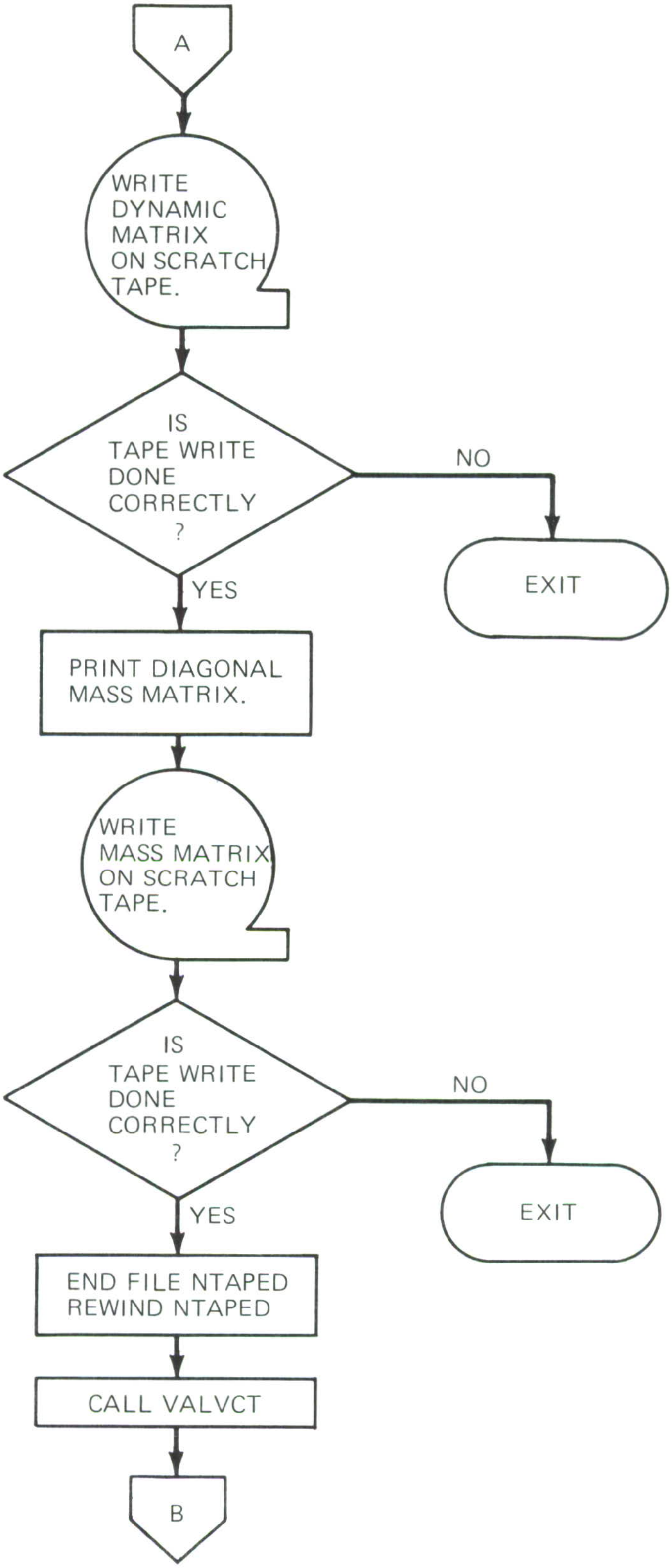
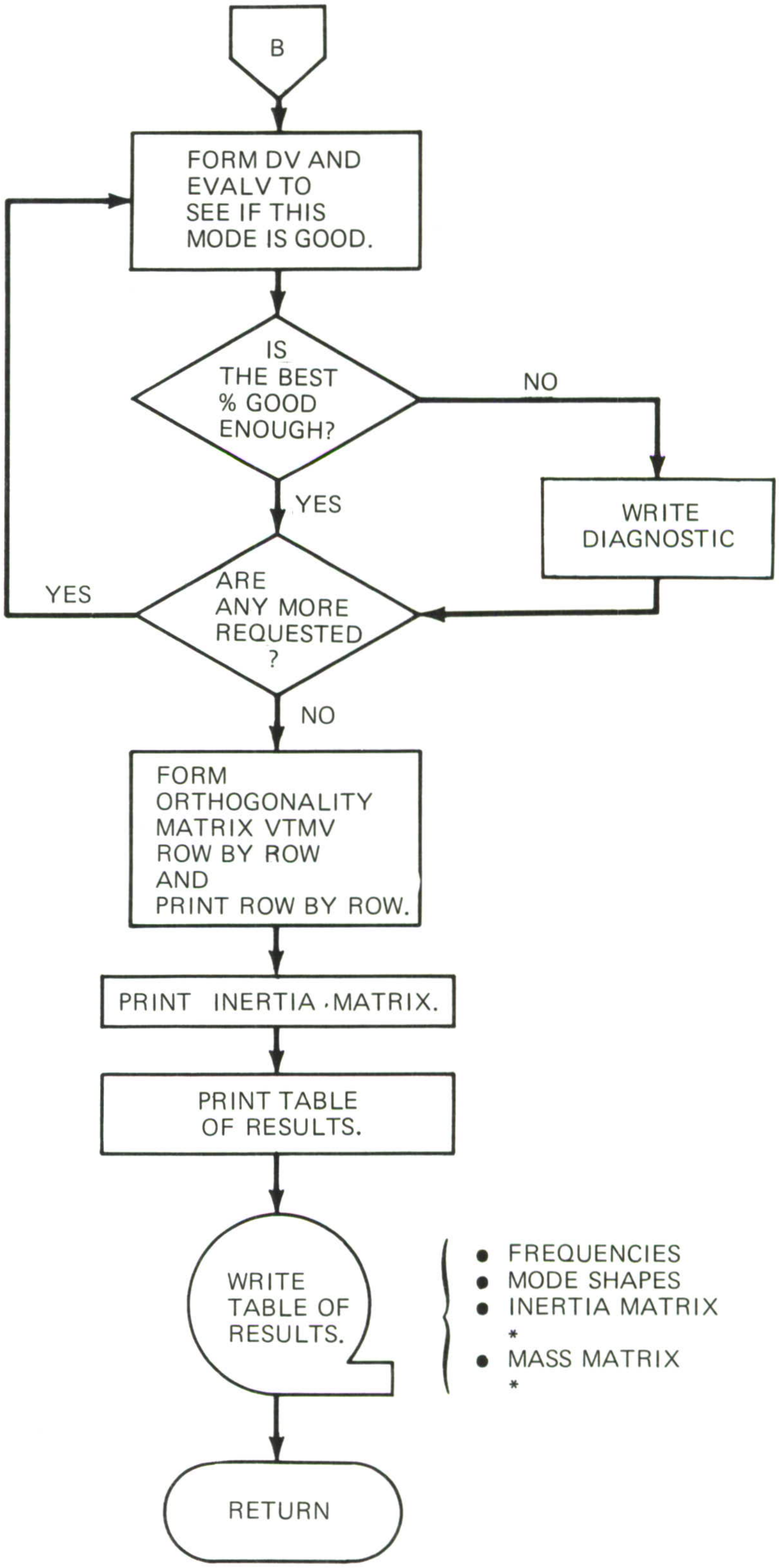

A
WRITE DYNAMIC MATRIX ON SCRATCH TAPE.
IS TAPE WRITE DONE CORRECTLY ?
NO
EXIT
YES
PRINT DIAGONAL MASS MATRIX.
WRITE MASS MATRIX ON SCRATCH TAPE.
IS TAPE WRITE DONE CORRECTLY ?
NO
EXIT
YES
END FILE NTAPED
REWIND NTAPED
CALL VALVCT
B

Figure 24—Continued


B
FORM DV AND EVALV TO SEE IF THIS MODE IS GOOD.
IS THE BEST % GOOD ENOUGH?
NO
WRITE DIAGNOSTIC
YES
ARE ANY MORE REQUESTED ?
YES
NO
FORM ORTHOGONALITY MATRIX VTMV ROW BY ROW AND PRINT ROW BY ROW.
PRINT INERTIA MATRIX.
PRINT TABLE OF RESULTS.
WRITE TABLE OF RESULTS.
• FREQUENCIES
• MODE SHAPES
• INERTIA MATRIX
*
• MASS MATRIX
*
RETURN

* END FILE

Figure 24—Concluded

b. Programming Organization

The FREMOD module consists of a control routine and seven subroutines. Routine FREMOD controls generation of the eigenvalue-eigenvectors. The functions of the seven subroutines follow.

(1) Subroutine Descriptions

Subroutine VALVCT calls six subroutines that together comprise the QR algorithm. The subroutine VALVCT input/output parameters are DYNMAT, N, MODES, EVAL, and VECMAT:

Parameter	Function
DYNMAT	Dynamic matrix (not returned)
N	Size of current dynamic matrix
MODES	Number of modes desired
EVAL	Array containing eigenvalues
VECMAT	Array containing eigenvectors

The function of VALVCT is to generate eigenvalues and eigenvectors. Given the matrix equation

$$\Big[[D] - r \lceil I \rfloor \Big] \; \{\phi\} = 0 \tag{1}$$

where: $[D]$ = dynamic matrix

r = eigenvalue

$\lceil I \rfloor$ = identity matrix

$\{\phi\}$ = eigenvector

subroutine VALVCT and its associated subroutines find the set of characteristic roots r (eigenvalues) and the vectors $\{\phi\}$. Natural frequencies are calculated in the main program from the eigenvalues by the equation

$$\omega = \frac{1}{2\pi \sqrt{r}} \tag{2}$$

The eigenvalue solution is accomplished using the technique commonly known as the QR algorithm.

The QR algorithm is based on the concept of a similarity transformation. To illustrate the similarity transformation and show its usefulness, let us premultiply equation (1) by the arbitrary nonsingular matrix $[A]$ yielding:

$$[A]\left|[D] - r\lceil I \rfloor\right| \{\phi\} = 0 \tag{3}$$

Now assume a vector $\{X\}$ such that $[A]^{-1}\{X\} = \{\phi\}$ and substitute the value into equation (3) yielding:

$$\begin{aligned} \left|[A]\,[D] - r\,[A]\lceil I \rfloor\right| \;[A]^{-1}\{X\} &= 0 \\ \left|\,[A]\,[D]\,[A]^{-1} - r\lceil I \rfloor\right| \;\{X\} &= 0 \end{aligned} \tag{4}$$

Examination of equation (4) shows that the new matrix $[A][D][A]^{-1}$ has the same eigenvalues as equation (1). However, the transformation $[A]$ is required to get back to the original vector space containing vectors $\{\phi\}$, i.e. $[A]\{\phi\} = \{X\}$. By judicious choice of a series of $[A]$ matrices, the form of the original matrix may be changed to suit one's needs. The transformation represented by equation (4) is known as the similarity transformation. The process is as follows.

(a) Step 1

Subroutine HESSEN transforms the dynamic matrix $[D]$ (N-by-N) to "upper-Hessenberg" form $[H]$ ($h_{ij} = 0,\ i > j + 1$).

By using similarity transformations, the eigenvalues are guaranteed to be left unchanged. One premultiplication of $[D]$ is required in eliminating the terms below the subdiagonal in the j^{th} column, and postmultiplication is required to complete the similarity transformation. However, before premultiplication and postmultiplication at the j^{th} step, a row and column interchange is performed to ensure that the term $d_{j+1,j}$ is larger than any term below it in column j. The equation is

$$[H] = \left[S_{n-2}\right]\left[U_{n-2}\right]\cdots\left[S_1\right]\left[U_1\right]\left[D\right]\left[U_1\right]^{-1}\left[S_1\right]^{-1}\cdots\left[U_{n-2}\right]^{-1}\left[S_{n-2}\right]^{-1} \tag{5}$$

where $[S_j]$ eliminates the terms below the subdiagonal in column j, and $[U_j]$ performs the row interchange to maintain numerical stability.

(b) Step 2

Subroutine QRITER performs the following calculations:

A matrix $[P]$ is found such that $[P][H]$ is upper triangular and $[P][H][P]^{-1}$ is again of upper-Hessenberg form. The sequence of matrices $[H_1]$, $[H_2]$, . . . $[H_k]$ is now formed as shown below:

$$\left[H_1\right] = \left[P_1\right]\left[H_o\right]\left[P_1\right]^{-1}$$

$$\left[H_2\right] = \left[P_2\right]\left[H_1\right]\left[P_2\right]^{-1}$$

$$\vdots$$

$$\left[H_k\right] = \left[P_k\right]\left[H_{k-1}\right]\left[P_k\right]^{-1}$$

It has been demonstrated (reference 4) that this sequence converges to an upper triangular matrix if the roots r are real.

Convergence is approximately inversely proportional to the ratio $(r_i/r_{i-1})^k$ for the i^{th} root where $|r_1| > |r_2| > |r_3| \ldots > |r_n|$. This being the case, the acceleration technique consists of a shift of origin by an amount that is a close approximation of the root r_i . It is easy to find a close approximation since $h_{ii} \rightarrow r_i$. (Actually, the roots of the 2-by-2 matrix whose diagonal terms are $h_{i-1,i-1}$ and h_{ii} are used.) The shifting is performed by subtracting the approximation (say $\bar{r}_i$) off the diagonal of $[H]$ at the k^{th} step. The appropriate transformations are then applied and then $\bar{r}_i$ is added back to the diagonal. It is easy to show that the roots were unchanged, but the roots of the matrix $[H]$ during the actual step were $r_i - \bar{r}_i$. Therefore, the rate of convergence during that step was proportional to $\left(r_{i-1} - \bar{r}_i\right)^k / \left(r_i - \bar{r}_i\right)^k$, which will be a large number.

(c) Step 3

We now have a triangular matrix in which the diagonal elements are the required eigenvalues. Subroutine SORTRT orders the roots according to absolute value and stores them in a new array.

(d) Step 4

We have left only the problem of computing the vectors using the triangular matrix $[H_k]$. We first compute the vectors $\{\phi_T\}$ corresponding to the triangular matrix $[H_k]$. To obtain the vector corresponding to a particular eigenvalue (say the i^{th} diagonal term of $[H_k]$, i.e. r_i) , we use the following equation and observe that all elements of $\{\phi_T\}$ below the i^{th} must be zero.

$$\left[[H_k] - r_i \lceil I \rfloor \right] \{\phi_T\} = 0 \tag{6}$$

We may arbitrarily choose the value 1.0 for the i^{th} element of $\{\phi_T\}$ and then proceed back up the vector obtaining each successive term by solving the equation represented by the corresponding row in the matrix equation. This is done by subroutine VECTOR.

Subroutine TRANS1 performs the following calculations in step 5.

(e) Step 5

The transformations that were required to perform step 2 are now retrieved from tape and accumulated into the matrix $[P]^{-1}$. That is

$$\left[P\right]^{-1} = \left[P_1\right]^{-1} \left[P_2\right]^{-1} \cdots \left[P_k\right]^{-1} \tag{7}$$

A vector $\{\phi_H\}$ corresponding to the Hessenberg matrix $[H]$ may now be computed as follows:

$$\{\phi_H\} = [P]^{-1} \{\phi_T\} \tag{8}$$

Subroutine TRANS2 performs the calculations of step 6.

(f) Step 6

The quantities necessary to reconstruct the transformations $[S_1]$, $[S_2]$, . . . $[S_{n-2}]$ of step 1 were temporarily stored in the lower part of matrix $[\bar{D}]$ for conservation of storage. (The matrix $[S]$ here is not to be confused with the stress deflection matrix used earlier.) Only n terms of storage were necessary to contain the information required to reproduce the transformations $[U_1]^{-1}$, $[U_2]^{-1}$, . . . $[U_{n-2}]$. The following product is now computed:

$$\{\phi\} = \left[U_1\right]^{-1} \left[S_1\right]^{-1} \cdots \left[U_{n-2}\right]^{-1} \left[S_{n-2}\right]^{-1} \{\phi_H\} \tag{9}$$

To compute $[U_i]$, $[U_1]^{-1}$, interchange rows ℓ and m and form $[U_i]$ as follows:

$$U_{jj} = 1, \; j \neq \ell, \; m$$

$$U_{\ell m} = U_{m \ell} = 1$$

All other terms are zero.

Also note that

$$\left[U_i\right] = \left[U_i\right]^{-1}$$

To compute $[S_i]$, $[S_i]^{-1}$, use the notation $[\bar{D}] = [d_{ij}]$ for the dynamic matrix $[D]$ and $[S] = [S_{ij}]$. The terms below the diagonal in column $(k + 1)$ of the general matrix $[S_k]$ are $-d_{k+2,k}/d_{k+1,k}$, $-d_{k+1,k}/d_{k+1,k}$, . . . $-d_{nk}/d_{k+1,k}$. In addition,

$$S_{ij} = 1, \; i = j$$

All others terms are zero.

Equation (10) is the formulation for $[S_1]$ for $n = 5$. It can be readily noted that $[S_1]^{-1}$ may be obtained from $[S_1]$ by changing the sign of the elements below the diagonal.

$$[S_1] = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & -\dfrac{d_{31}}{d_{21}} & 1 & 0 & 0 \\ 0 & -\dfrac{d_{41}}{d_{21}} & 0 & 1 & 0 \\ 0 & -\dfrac{d_{51}}{d_{21}} & 0 & 0 & 1 \end{bmatrix} \qquad (10)$$

To compute $[P_i]$,

$$\left[P_i\right] = \left[\bar{P}_{n-1}\right] \cdot \cdot \cdot \left[\bar{P}_2\right]\left[\bar{P}_1\right] \qquad (11)$$

where $[\bar{P}_k]$ eliminates the subdiagonal terms in column k . At the time that the rotational transformations $[P_i]$ are required, the original dynamic matrix $[D]$ has been reduced to Hessenberg form $[H]$:

$$[H] = [h_{ij}] \tag{12}$$

Specifically $[\bar{P}_k]$ is formed as follows:

$$L_k = \left(h_{kk}^2 + h_{k+1,k}^2\right)^{1/2}$$

$$\cos\,\theta_k = h_{kk}\,L_k$$

$$\sin\,\theta_k = h_{k+1,k}\,L_k$$

If

$$[\bar{P}_k] = [p_{ij}]$$

Then

$$\bar{P}_{ii} = 1,\ \ i \neq k, k+1$$

$$\bar{P}_{kk} = \cos\theta\ ,\ \bar{P}_{k,\,k+1} = \sin\theta$$

$$\bar{P}_{k+1,k} = -\sin\theta\ ,\ \bar{P}_{k+1,k+1} = \cos\theta$$

$$\bar{P}_{ij} = 0$$

for all other i and j,

The matrix described above is known as Givens' rotational matrix. Note that no additional time is required to compute the inverse since

$$[\bar{P}_k]^{-1} = [\bar{P}_k]^T$$

(g) General-Purpose Subroutines

Subroutine	Function
INRPRD	To form the inner product of two vectors (See appendix II.)
READTP WRTETP	Binary tape input/output subroutines for TL01 compatibility (See appendix II.)

(2) Flow Diagrams

Flow diagrams for FREMOD subroutines are shown in figures 25 through 32.

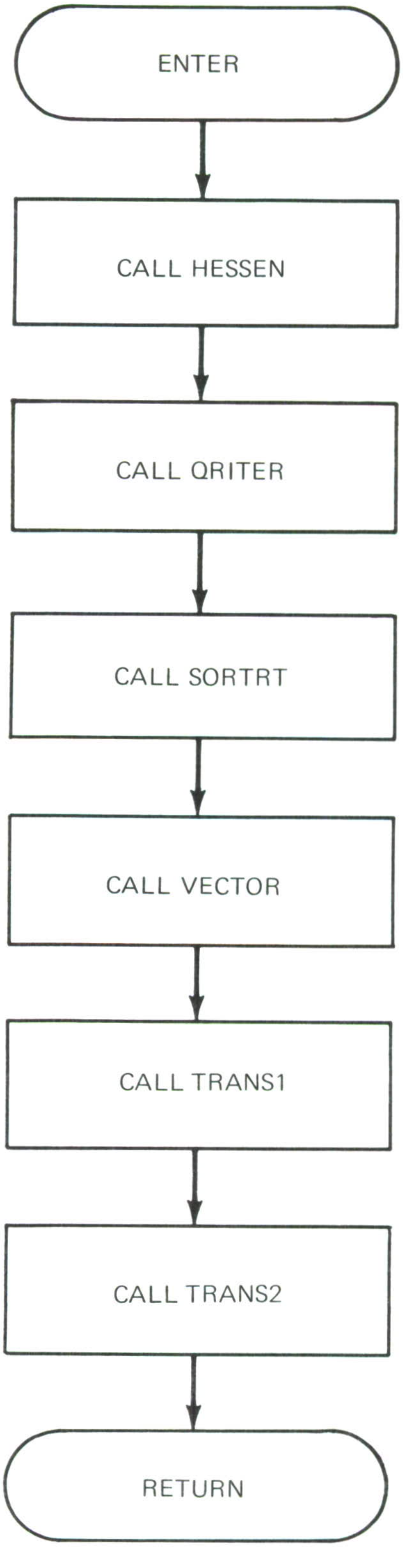

ENTER
CALL HESSEN
CALL QRITER
CALL SORTRT
CALL VECTOR
CALL TRANS1
CALL TRANS2
RETURN

Figure 25. VALVCT Flow Chart

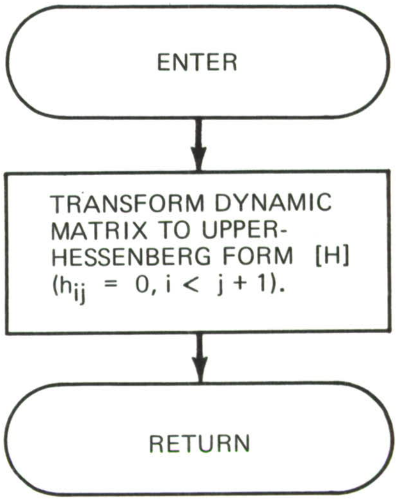

ENTER
TRANSFORM DYNAMIC MATRIX TO UPPER-HESSENBERG FORM [H] ($h_{ij} = 0, i < j + 1$).
RETURN

Figure 26. HESSEN Flow Chart

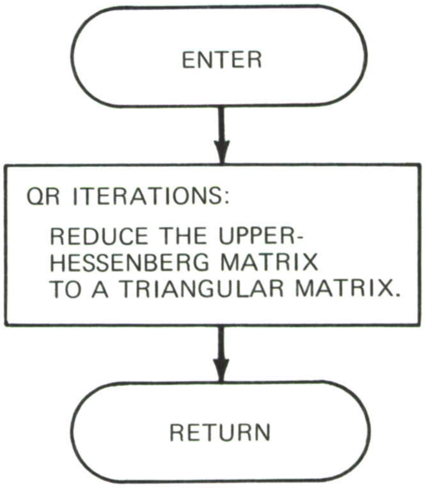

ENTER
QR ITERATIONS:
REDUCE THE UPPER-HESSENBERG MATRIX TO A TRIANGULAR MATRIX.
RETURN

Figure 27. QRITER Flow Chart

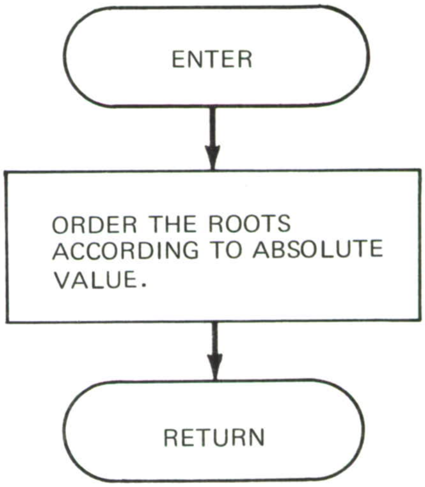

ENTER
ORDER THE ROOTS ACCORDING TO ABSOLUTE VALUE.
RETURN

Figure 28. SORTRT Flow Chart

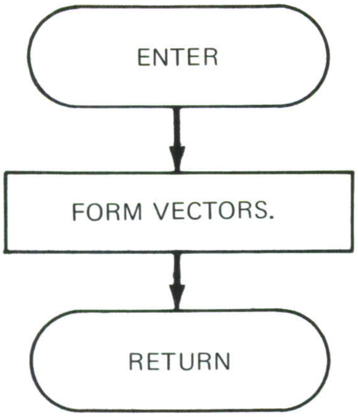

ENTER
FORM VECTORS.
RETURN

Figure 29. VECTOR Flow Chart

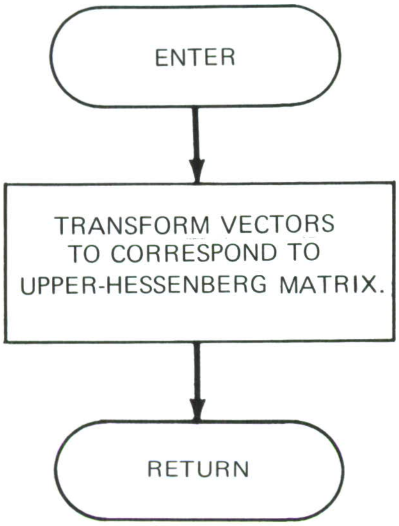

ENTER
TRANSFORM VECTORS TO CORRESPOND TO UPPER-HESSENBERG MATRIX.
RETURN

Figure 30. TRANS1 Flow Chart

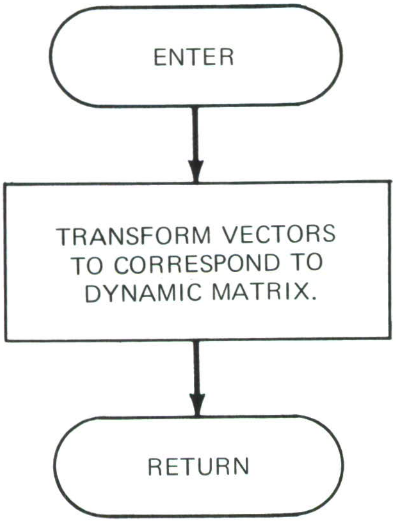

ENTER
TRANSFORM VECTORS TO CORRESPOND TO DYNAMIC MATRIX.
RETURN

Figure 31. TRANS2 Flow Chart

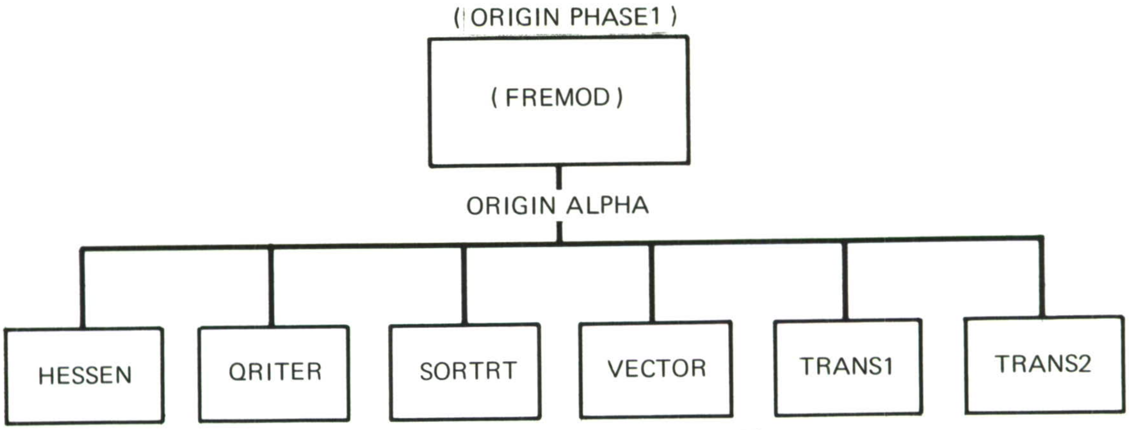


Figure 32. FREMOD Overlay Map

c. FREMOD Subroutine List

Subroutine	Function
FREMOD	This is the main program. It handles input, output, and generation of the dynamic matrix from the flexibility and mass matrices. Subroutine VALVCT is called for the QR solution
VALVCT	Calls successive subroutines, which together form an eigenvalue-eigenvector solution package using the QR algorithm
HESSEN	Transforms the dynamic matrix to upper-Hessenberg form
QRITER	Reduces the upper-Hessenberg matrix to a triangular matrix, the eigenvalues being the diagonal terms (QR iteration scheme)
SORTRT	Orders the eigenvalues according to absolute value and stores them in a new array. This array is needed in forming the eigenvectors.
VECTOR	Computes the eigenvectors
TRANS1	Transforms the eigenvectors (found using the triangular matrix) to correspond to the upper-Hessenberg matrix
TRANS2	Transforms the eigenvectors corresponding to the upper-Hessenberg matrix to vectors corresponding to the dynamic matrix

IV

PHASE II—RANDOM LOAD AND RESPONSE PROGRAMS

Phase II is an integrated set of computer programs for determining sonic loads and random structural responses. The execution of this phase is controlled by the PHASE2 routine. The RANLOD module and RANSO modules are called from the control program. The program listings for phase II are included in appendix IV.

1. RANDOM LOADING MODULE (RANLOD)

a. General Description

RANLOD generates force cross-power spectral density (cross-PSD) matrices describing the applied forces. The mathematical model is based on properties of decayed progressive sound waves. The RANLOD module consists of five FORTRAN-coded subroutines and associated system and general input/output (I/O) subroutines.

Other loading modules can be used in place of RANLOD when the analysis requires a different form of force loading. These modules must be compatible with the basic RANVIB system.

In addition to basic problem information, RANLOD requires data input on cards describing the panel geometry, wave data, and option control parameters. A detailed discussion of the input and card format is contained in the Engineering User's Guide, reference 3.

Figure 33 illustrates the logical placement of RANLOD in the RANVIB system. The overlay structure is discussed in section IV1.b.

The RANLOD module is called once during the execution of phase II to generate the required matrices. In addition to the frequencies, solution options, and control parameters stored in the labeled common blocks by the phase II control program, RANLOD reads card inputs. It then proceeds to generate the force cross-PSD matrices for the required solution option. They are stored on tape and printed as they are generated. The matrices are stored on tape in a compatible format for the various solution options the user desires. The printing is controlled by the user as described in the card input. Figure 34 illustrates RANLOD input/output data flow.

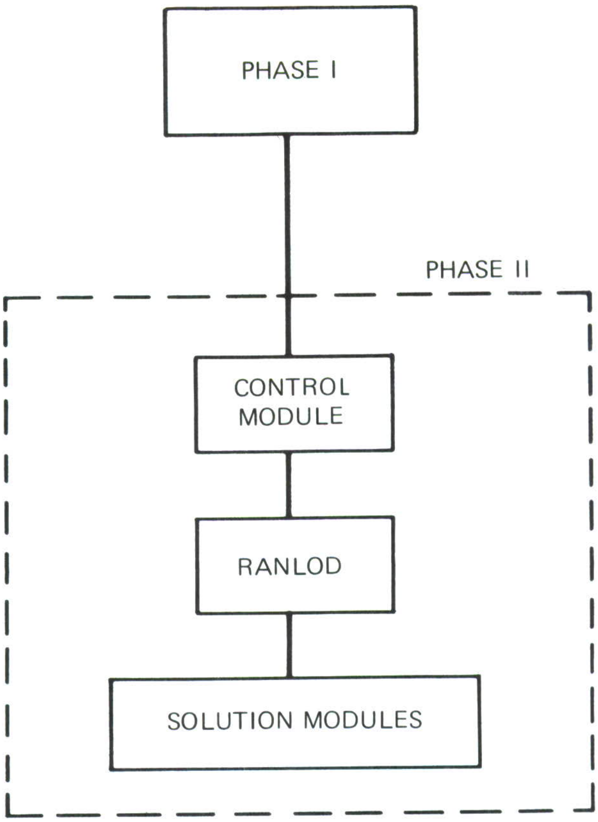

PHASE I
PHASE II
CONTROL MODULE
RANLOD
SOLUTION MODULES

Figure 33. RANLOD Placement

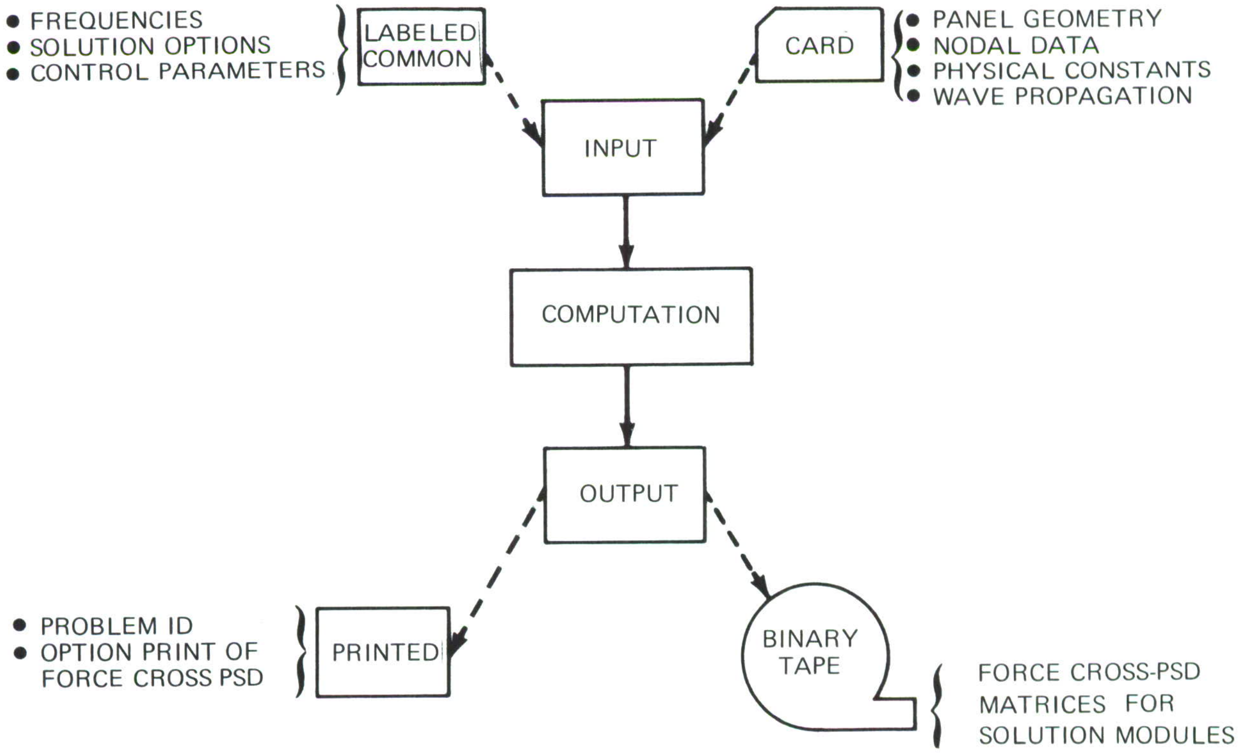

● FREQUENCIES
● SOLUTION OPTIONS
● CONTROL PARAMETERS
LABELED COMMON
CARD
● PANEL GEOMETRY
● NODAL DATA
● PHYSICAL CONSTANTS
● WAVE PROPAGATION
INPUT
COMPUTATION
OUTPUT
● PROBLEM ID
● OPTION PRINT OF FORCE CROSS PSD
PRINTED
BINARY TAPE
FORCE CROSS-PSD MATRICES FOR SOLUTION MODULES

Figure 34. RANLOD Input/Output Diagram

The five subroutines that form the RANLOD module are as follows:

Subroutine	Function
RANLOD	Control subroutine that reads input and problem initializations and calls all subroutines needed for generation
ARIA	Calculates the areas associated with the retained nodes
CONST	Calculates problem constants needed in generation
NOISOR	Computes the force cross-PSD matrices
OUTPUT	Controls printing and formation of binary output tapes

The logic flow of the RANLOD module is shown in figure 35.

(1) Input/Output Functions

All card inputs are via logical tape 5, and all printed outputs are via logical tape 6. Logical tapes 2, 17, and 14 are used for all binary outputs of the force cross-PSD matrices. These tapes are written from subroutine OUTPUT using subroutine WRTETP. A detailed map of these tapes is given in the description of subroutine OUTPUT.

(2) Restrictions

The RANLOD restrictions are discussed in detail in the Engineering User's Guide, reference 3. These restrictions are basic problem size and mathematical limitations in analyses. If it is desired to replace RANLOD with another loading module, the following items must be adhered to.

(a) The labeled common blocks BLK1, BLK2, and BLK3 must be retained and the size maintained compatible with phase II definitions. The force cross-PSD matrix size must be maintained to less than or equal to the phase II limits.

(b) The binary tape output of the force cross-PSD matrices must be maintained in the compatible format for the solution modules.

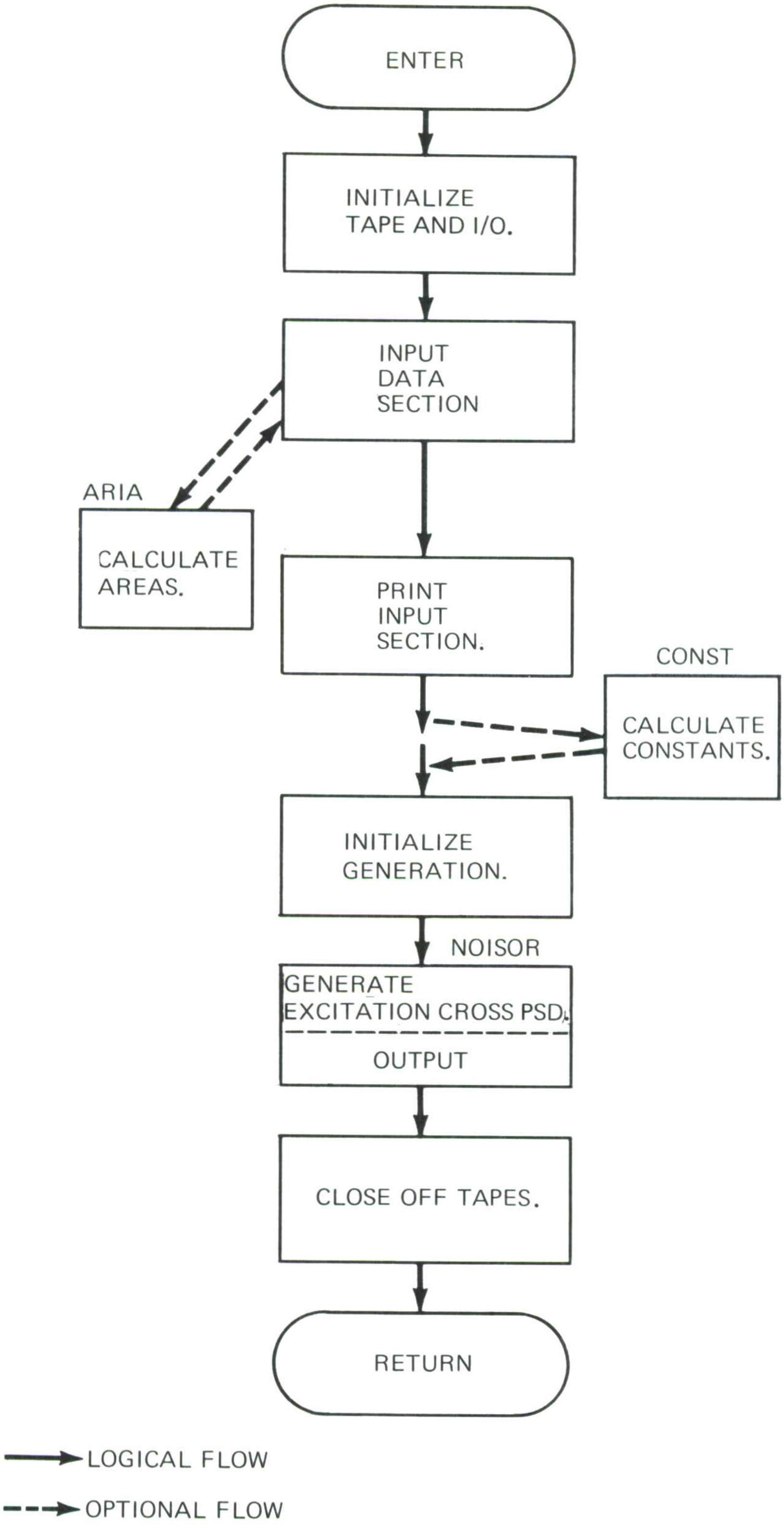

ENTER
INITIALIZE TAPE AND I/O.
INPUT DATA SECTION
ARIA
CALCULATE AREAS.
PRINT INPUT SECTION.
CONST
CALCULATE CONSTANTS.
INITIALIZE GENERATION.
NOISOR
GENERATE EXCITATION CROSS PSD.
OUTPUT
CLOSE OFF TAPES.
RETURN
LOGICAL FLOW
OPTIONAL FLOW

Figure 35. RANLOD Subroutine Flow

b. Programming Organization

(1) Subroutine Descriptions

This section discusses the purpose, methodology, restrictions, and inputs/outputs of the five FORTRAN subroutines.

(a) Subroutine RANLOD

Subroutine RANLOD is the controlling routine for the loading module. It is called by the phase II control program and returns to this program when generation is complete.

Method:	Subroutine RANLOD accepts control from the phase II main program and controls the generation of the force cross-PSD matrices. It uses the information in labeled common blocks BLK1, BLK2, and BLK3 to generate the required solution option. Labeled common blocks BLK4, BLK5, and BLK6 are established for communication between RANLOD subroutines. Figure 36 is a flow chart of the RANLOD subroutine.
Input:	Input is via two modes. The first is labeled common from phase II control. The second mode of input is cards. The content and card format are discussed in detail in reference 3.
Error diagnostics:	None
Subroutines required:	ARIA, CONST, NOISOR
Argument list:	None
Length:	37001_8

(b) Subroutine ARIA

Subroutine ARIA computes the areas associated with the retained nodes in the structural idealization.

Method: Using the set of line-to-origin distances, the area A for node k is calculated using

$$A_k = 1/4\ (x_{i+1} - x_{i-1})\ (y_{j+1} - y_{j-1})$$

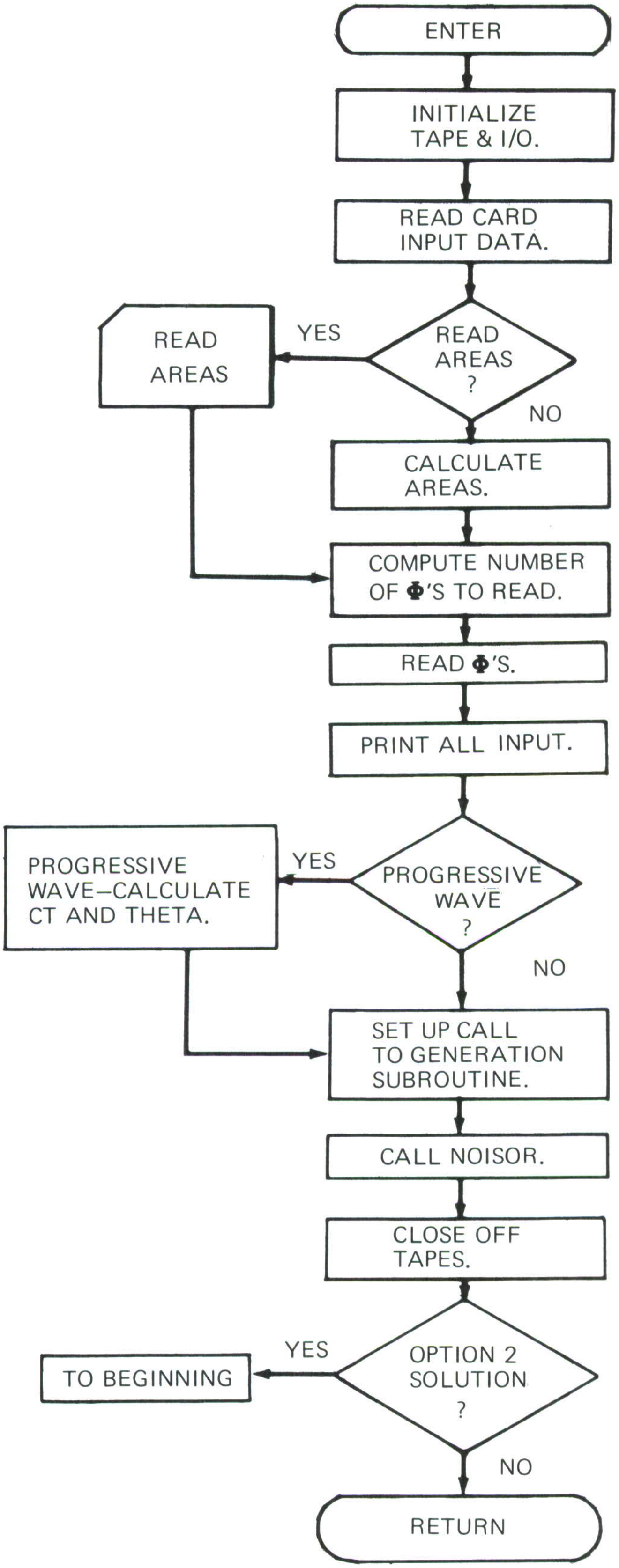

ENTER
INITIALIZE TAPE & I/O.
READ CARD INPUT DATA.
READ AREAS ?
YES
READ AREAS
NO
CALCULATE AREAS.
COMPUTE NUMBER OF Φ'S TO READ.
READ Φ'S.
PRINT ALL INPUT.
PROGRESSIVE WAVE ?
YES
PROGRESSIVE WAVE—CALCULATE CT AND THETA.
NO
SET UP CALL TO GENERATION SUBROUTINE.
CALL NOISOR.
CLOSE OFF TAPES.
OPTION 2 SOLUTION ?
YES
TO BEGINNING
NO
RETURN

Figure 36. RANLOD Flow Chart

where: $k = 1$, number of retained nodes
$i = 2$, number of nodes in x direction
$j = 2$, number of nodes in y direction

Figure 37 illustrates subroutine ARIA flow.

Input: Input is via labeled common.

Error diagnostics: None

Subroutines required: None

Argument list: None

Length: 101_8

(c) Subroutine CONST

Subroutine CONST calculates the angle θ and trace velocity c_t . Angle θ defines the direction that the trace of the pressure wave fronts propagate over the panel surface.

Method: Subroutine CONST is only called for a progressive wave. The methodology and input control for this calculation is described in reference 3. Figure 38 illustrates subroutine CONST flow.

Input: There is no input except through the subroutine argument list.

Error diagnostics: None

Subroutines required: None

Argument list:
CX input—The phase velocity along the panel in the x direction
CY input—The phase velocity along the panel in the y direction
CT output—Trace velocity
THETA output— θ , the angle between the direction of sound propagation and the x and y axes of the panel

Length: 141_8

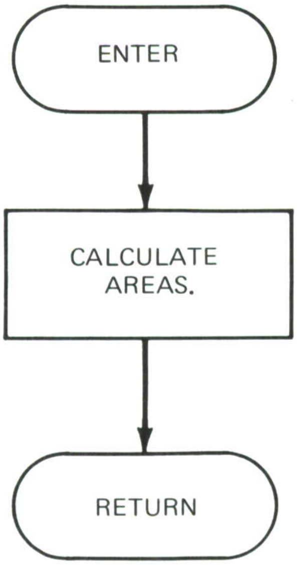

ENTER
CALCULATE AREAS.
RETURN

Figure 37. ARIA Flow Chart

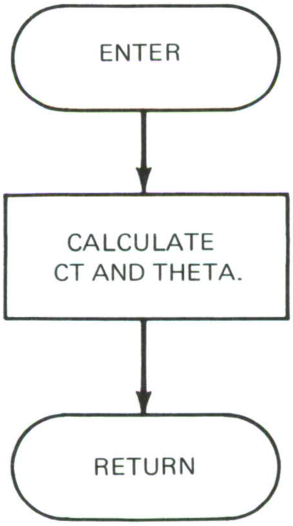

ENTER
CALCULATE CT AND THETA.
RETURN

Figure 38. CONST Flow Chart

(d) Subroutine NOISOR

Subroutine NOISOR calculates the force cross-PSD matrices. It receives control of the generation from routine RANLOD and returns to this subroutine when generation is complete.

Method: The detailed mathematical model from which subroutine NOISOR computes force cross PSD is discussed in reference 1. Figure 39 describes the flow of subroutine NOISOR. The subroutine computes the matrices in a direct manner with the mathematical model. The one exception to this is the computation of the separation distances ξ_{ij} and η_{ij} from the set of line-to-origin distances x_i and y_i . The separation distances are calculated as needed in the calculation of force cross PSD. This is done to conserve storage. The equations used in the separation calculation are as follows:

$$\xi_{ij} = x_j - x_i$$

and

$$\eta_{ij} = y_j - y_i$$

The computation of the subscripts is done by use of FORTRAN IV function subroutine MOD. This is done to take advantage of the repeating properties of the nodal geometry. A detailed flow chart of the separation calculation in program notation is shown in figure 40.

Input: Input to subroutine NOISOR is via labeled common and the subroutine argument list.

Error diagnostics: None

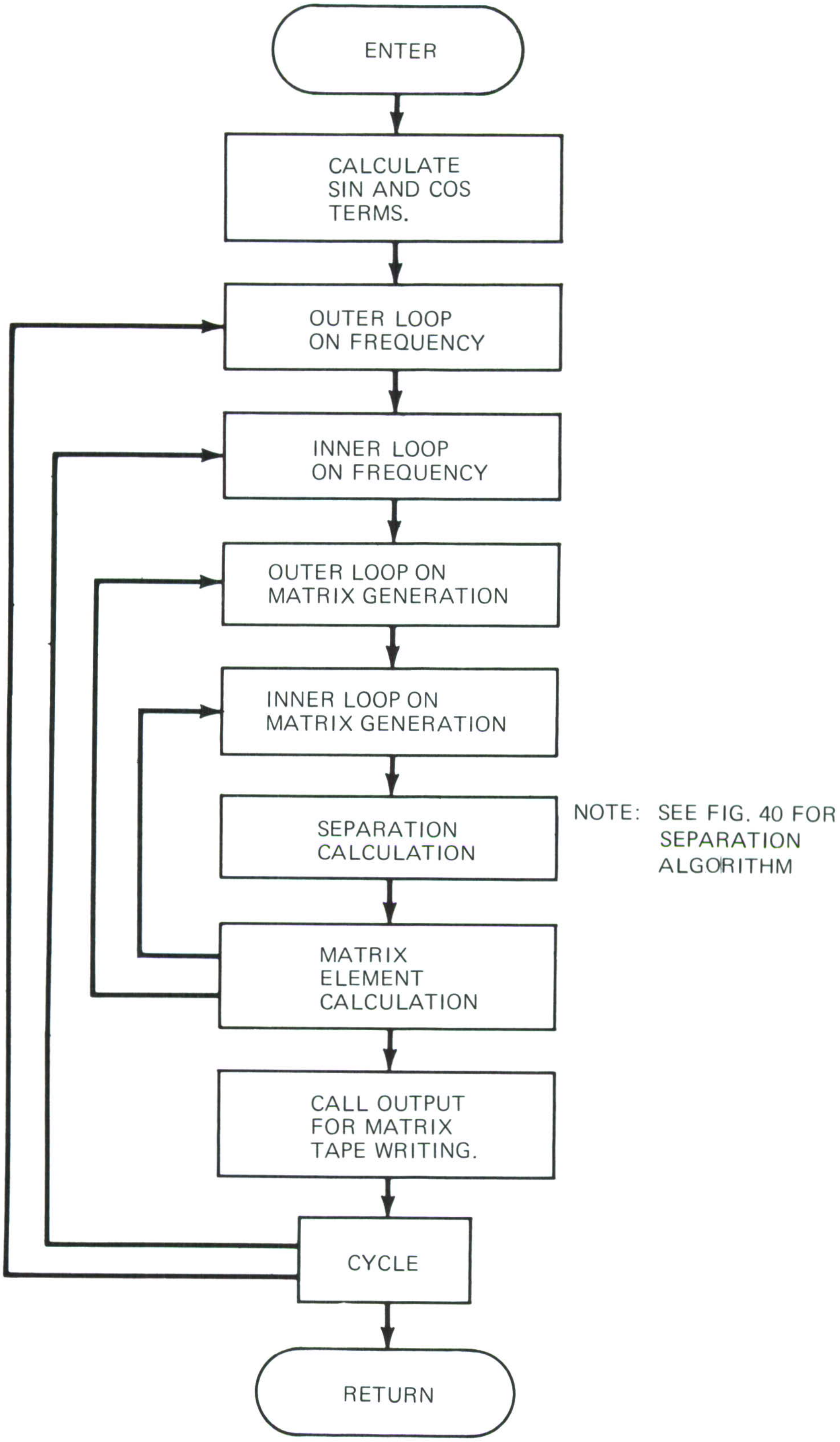
Subroutines required: OUTPUT

Argument list:

ILIM input—Limit on outer frequency loop

KLIM input—Limit on inner frequency loop

D input—Decay constant


ENTER
CALCULATE SIN AND COS TERMS.
OUTER LOOP ON FREQUENCY
INNER LOOP ON FREQUENCY
OUTER LOOP ON MATRIX GENERATION
INNER LOOP ON MATRIX GENERATION
SEPARATION CALCULATION
MATRIX ELEMENT CALCULATION
CALL OUTPUT FOR MATRIX TAPE WRITING.
CYCLE
RETURN

NOTE: SEE FIG. 40 FOR SEPARATION ALGORITHM

Figure 39. NOISOR Flow Chart

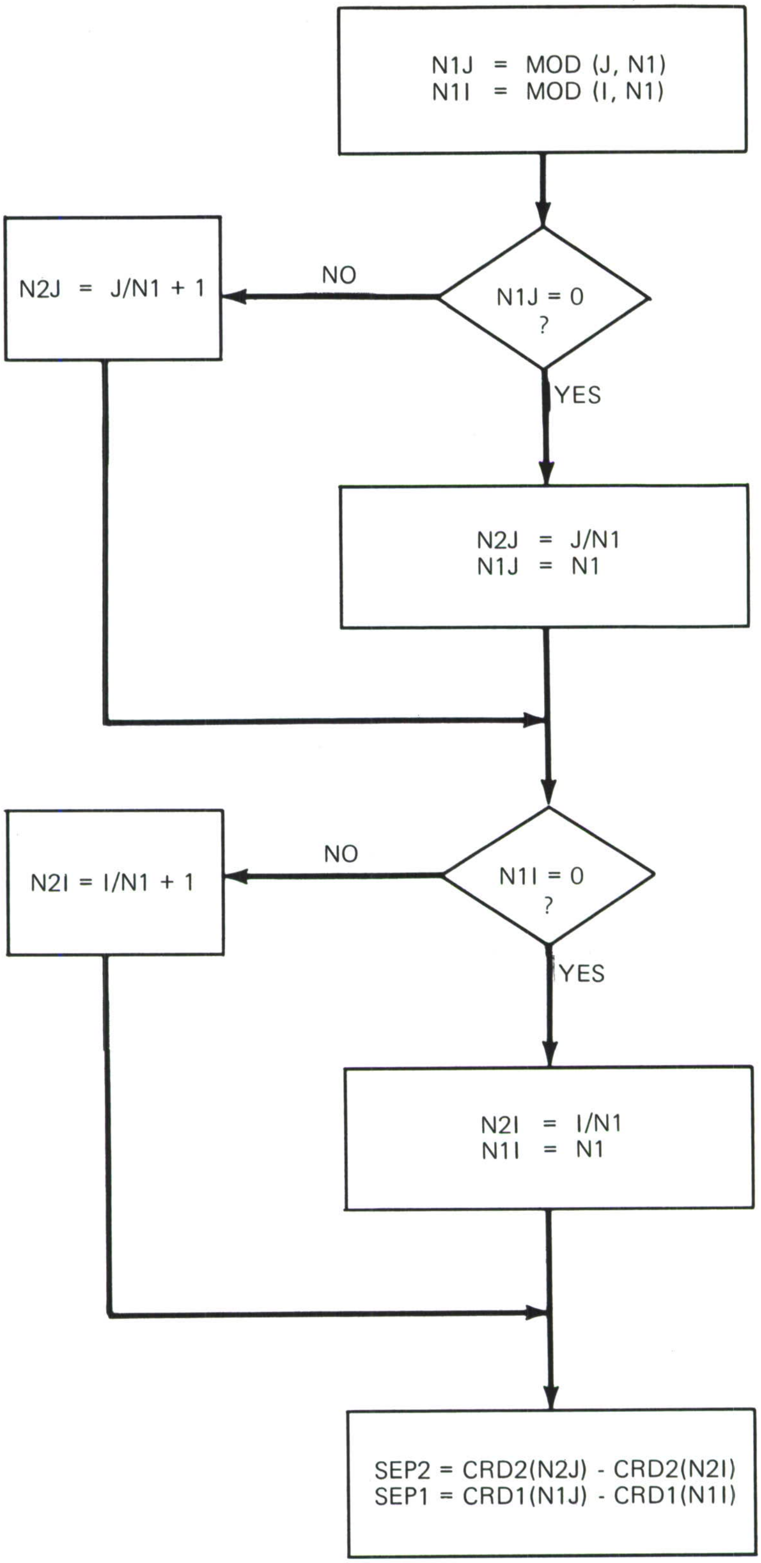

N1J = MOD (J, N1)
N1I = MOD (I, N1)
N1J = 0
?
NO
N2J = J/N1 + 1
YES
N2J = J/N1
N1J = N1
N1I = 0
?
NO
N2I = I/N1 + 1
YES
N2I = I/N1
N1I = N1
SEP2 = CRD2(N2J) - CRD2(N2I)
SEP1 = CRD1(N1J) - CRD1(N1I)

Figure 40. Separation-Algorithm Flow Chart

CT input—Trace velocity

THETA input— θ , propagation angle

CX input—Phase velocity in x direction

CY input—Phase velocity in y direction

Length: 601_8

(e) Subroutine OUTPUT

Subroutine OUTPUT is called from subroutine NOISOR each time the matri output is required, i.e. each frequency computation. The return is to subroutine NOISOR upon completion of OUTPUT.

Method: The subroutine has two output functions. One is to print the force cross-PSD matrices for as many frequencies as requested by the user. The other is to write the force cross-PSD matrices on binary tape in a format compatible with the solution modules. Item 2 is accomplished by the use of subroutine WRTETP, which is discussed in appendix I. Figure 41 describes the general flow of subroutine OUTPUT.

Input: Input is via labeled common and the subroutine argument list.

Error diagnostics: The error return from subroutine WRTETP is tested, and the appropriate comment printed if an error has occurred.

Subroutines required: WRTETP

Argument list: NPHI input—Count of the number of frequencies for which calculation has been completed

OMG input—The value of the current frequency (used in printing for identification)

Length: 573_8

(2) Tape Use

The detailed maps of the binary tapes for the various solution options are shown in figure 42.

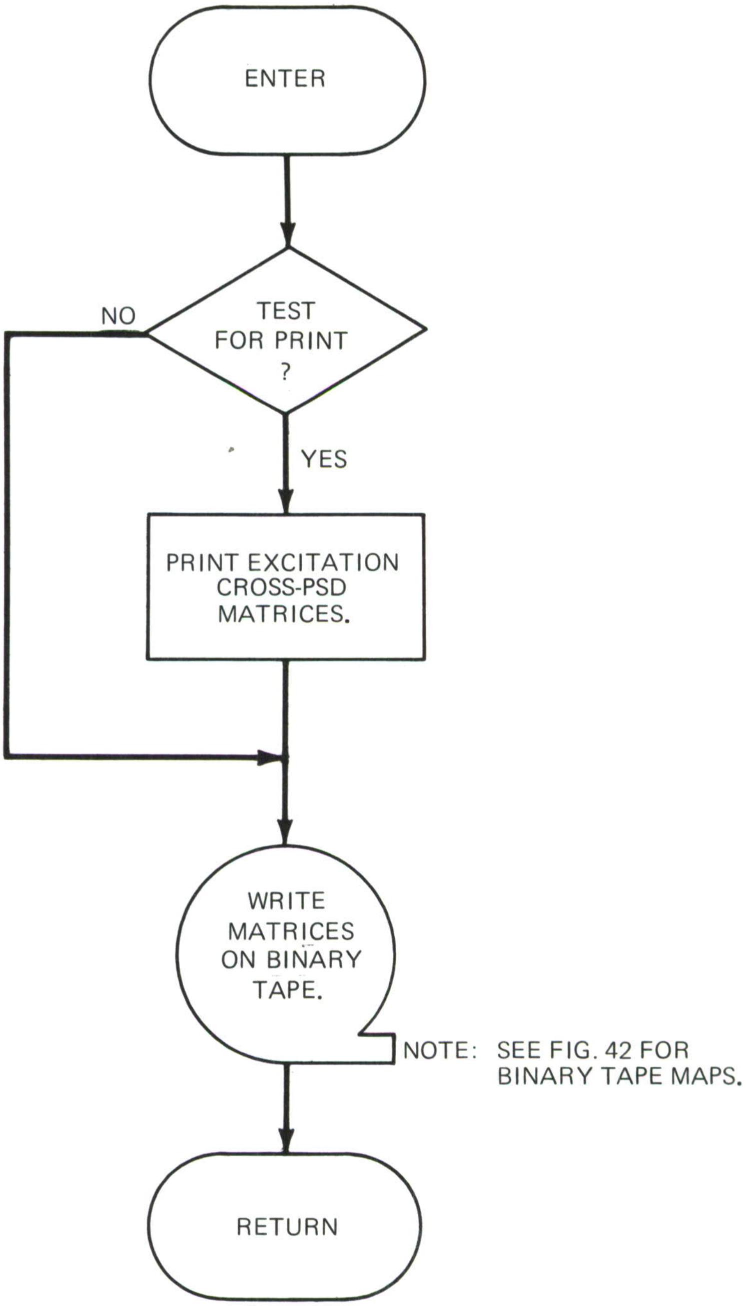
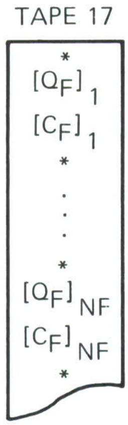
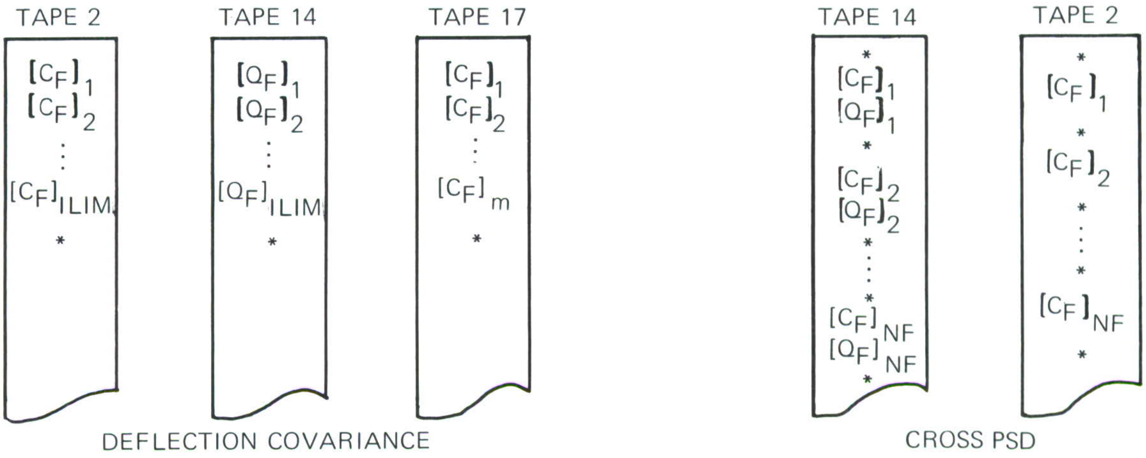

ENTER
TEST FOR PRINT ?
NO
YES
PRINT EXCITATION CROSS-PSD MATRICES.
WRITE MATRICES ON BINARY TAPE.
NOTE: SEE FIG. 42 FOR BINARY TAPE MAPS.
RETURN

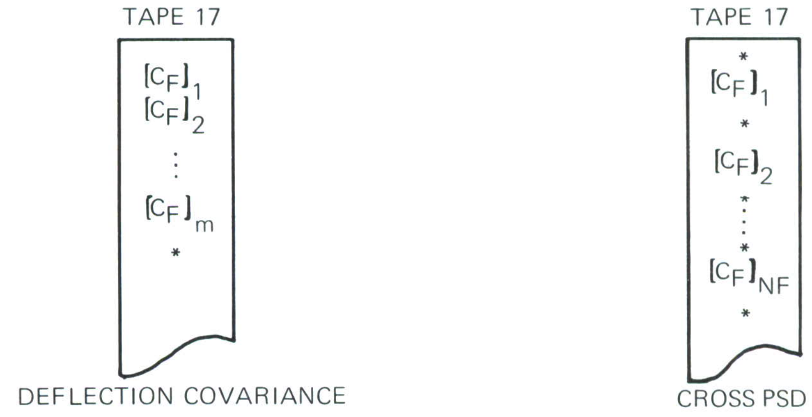
Figure 41. OUTPUT Flow Chart


TAPE 17
*
$[Q_F]_1$
$[C_F]_1$
*
*
$[Q_F]_{NF}$
$[C_F]_{NF}$
*

(a) OPTION 1


TAPE 2
$[C_F]_1$
$[C_F]_2$
$[C_F]_{ILIM}$
*
TAPE 14
$[Q_F]_1$
$[Q_F]_2$
$[Q_F]_{ILIM}$
*
TAPE 17
$[C_F]_1$
$[C_F]_2$
$[C_F]_m$
*
DEFLECTION COVARIANCE
TAPE 14
*
$[C_F]_1$
$[Q_F]_1$
*
$[C_F]_2$
$[Q_F]_2$
*
*
$[C_F]_{NF}$
$[Q_F]_{NF}$
*
TAPE 2
*
$[C_F]_1$
*
$[C_F]_2$
*
*
$[C_F]_{NF}$
*
CROSS PSD

(b) OPTION 2


TAPE 17
$[C_F]_1$
$[C_F]_2$
$[C_F]_m$
*
DEFLECTION COVARIANCE
TAPE 17
*
$[C_F]_1$
*
$[C_F]_2$
*
*
$[C_F]_{NF}$
*
CROSS PSD

(c) OPTION 3

* END FILE

Figure 42. Binary Output Tape Maps from RANLOD

2. RANDOM-RESPONSE SOLUTION PROGRAM (RANSO)

a. General Description

(1) Purpose—Logical Organization

The purpose of the RANSO (random-response solutions) module is to calculate random deflections and stress response solutions via matrix methods for complex structures subjected to random excitations. All matrix manipulations and solutions are performed in real matrix form. The logical flow through the RANSO solution is shown in figure 43. There are three solution options:

(1) Option 1—General viscous damping

(2) Option 2—Normal modes

(3) Option 3—Normal modes without cross terms

Options 2 and 3 are used when the excitation pressures vary slowly with frequency, i.e. broadband. When the excitation is not broadband, option 1 is used. For each option, there are four basic solutions involved:

(1) Deflection cross PSD

(2) Deflection covariance and second spectral moments

(3) Stress cross PSD

(4) Stress covariance and second spectral moments within elements

(2) Input/Output Functions

The data from the phase I output tape will be used as part of the input of phase II. Additional input from cards is required as discussed in the Engineering User's Guide, reference 3. All intermediate results will be stored on scratch tapes for temporary storage before proceeding to the next operational subroutine.

(3) Phase II RANSO Subroutines

There are two types of subroutines in the RANSO module. They are the standard FORTRAN IV subroutines and TL01 subroutines. The FORTRAN IV subroutines are described as follows:

(a) Method

(b) Input/output

(c) Errors

(d) Subroutines required

(e) Argument list

(f) Subroutine length—number of storage locations in octal required by the subroutine when compiled on the 7094 Mod II Version 13

(g) Flow diagrams

The subroutines that are written in TL01 matrix language (appendix I) are described as follows:

(a) A description of the subroutine

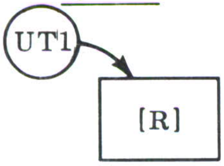
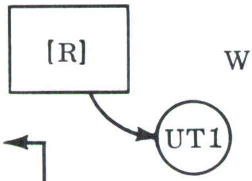
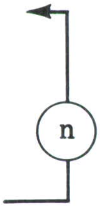
(b) Input tape storage and output tape storage

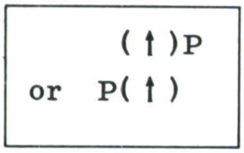
(c) Flow diagram

A discussion of READTP/WRTETP error messages is given in appendix I.

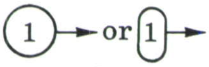
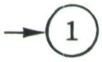
(4) FORTRAN and TL01 Flow-Diagram Conventions

(a) Symbols in TL01 Flow Charts

Symbol	Definition
	Read matrix [R] into core from tape unit UT1.
	Write matrix [R] onto tape unit UT1.
	Cycle n times over the enclosed operations.

Symbol	Definition
	Matrix operation
	Multiply the results from the preceding block by P.
n	Number of stress matrices
m	Number of mode shapes
NF	Number of frequencies

(b) Symbols for FORTRAN Diagrams Only

Symbol	Definition
*	File mark on tape
	Input from tape 1
	Output on tape 1
JD	Deflection covariance matrix
CPSD	Cross PSD

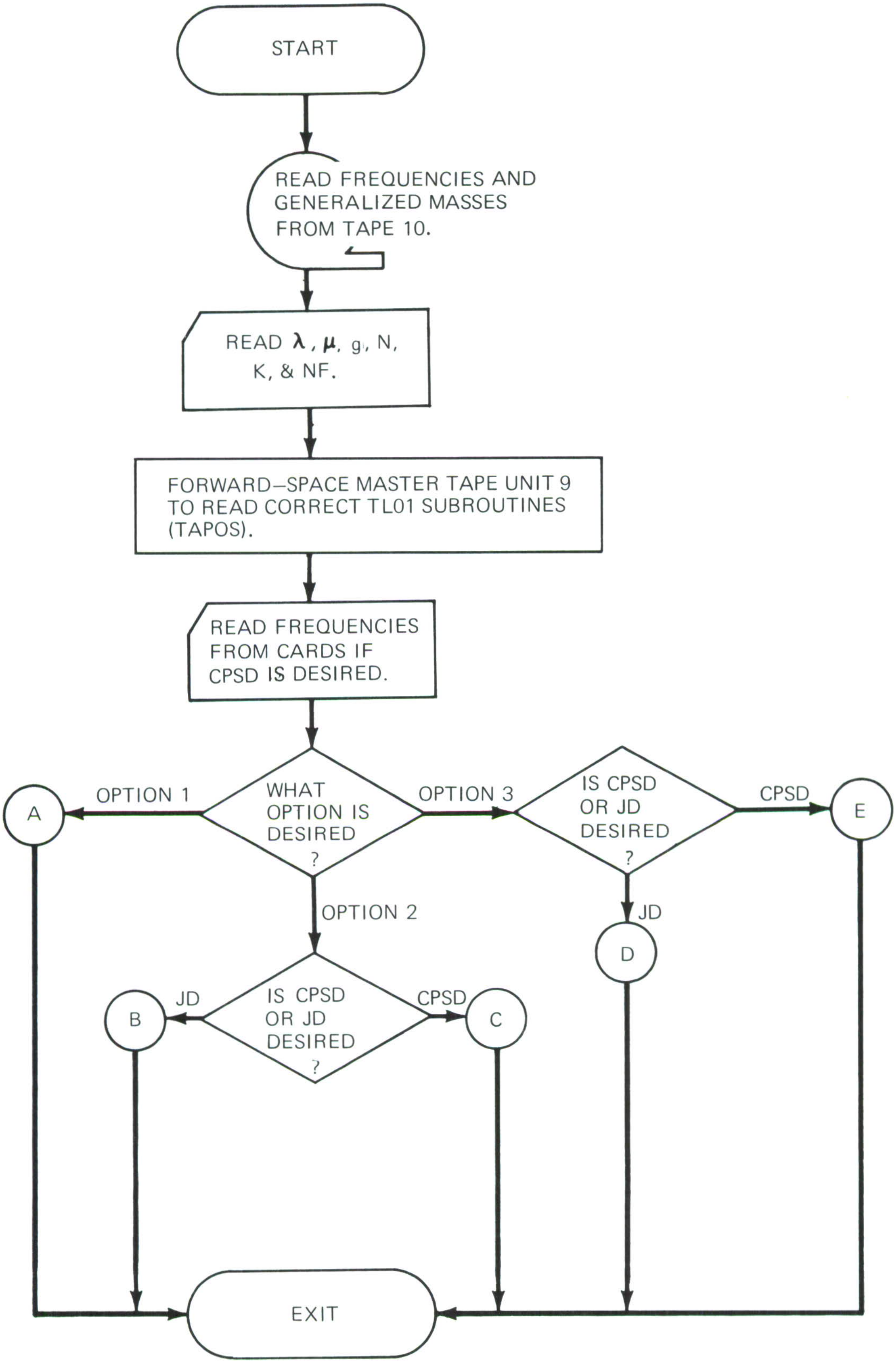
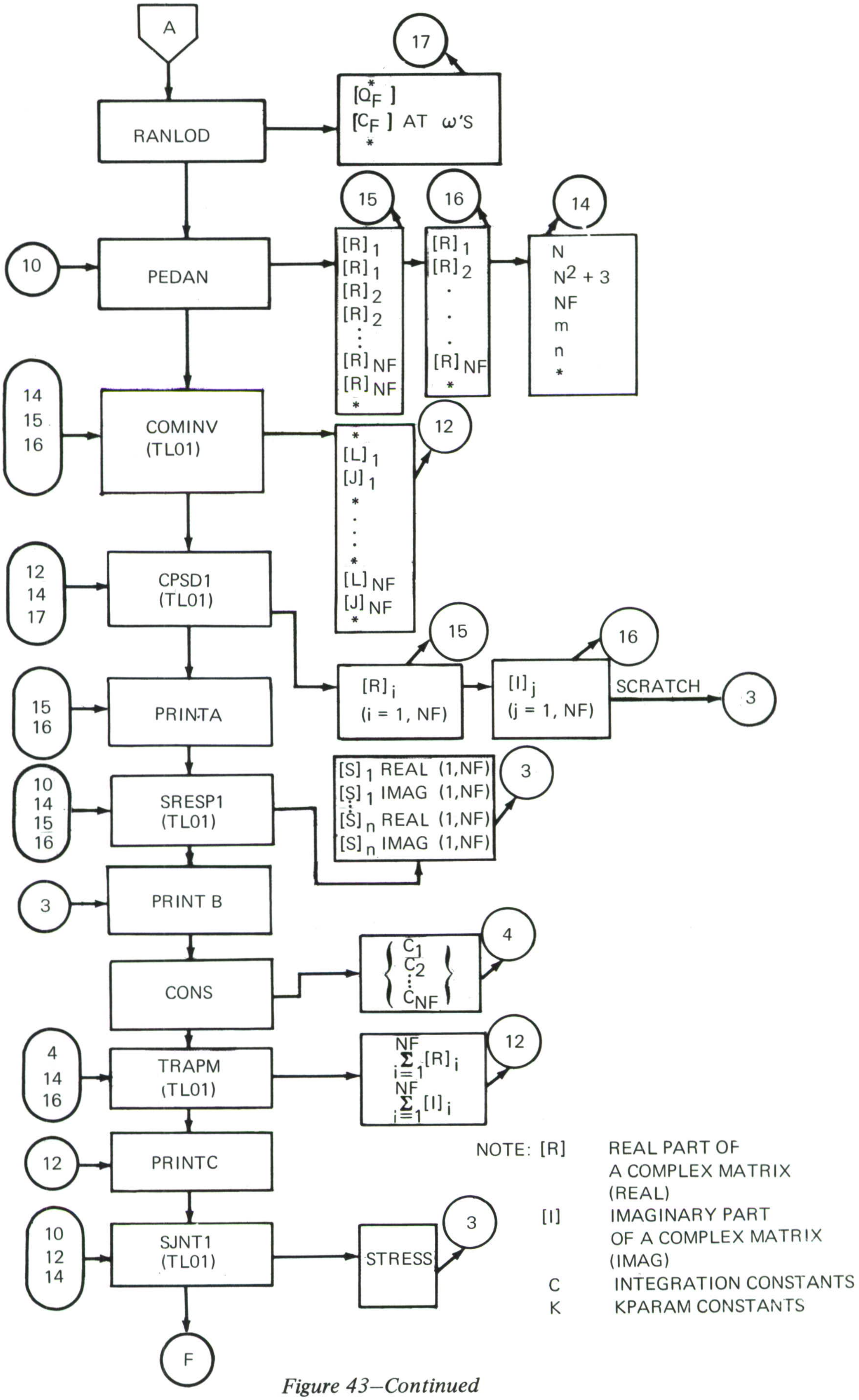
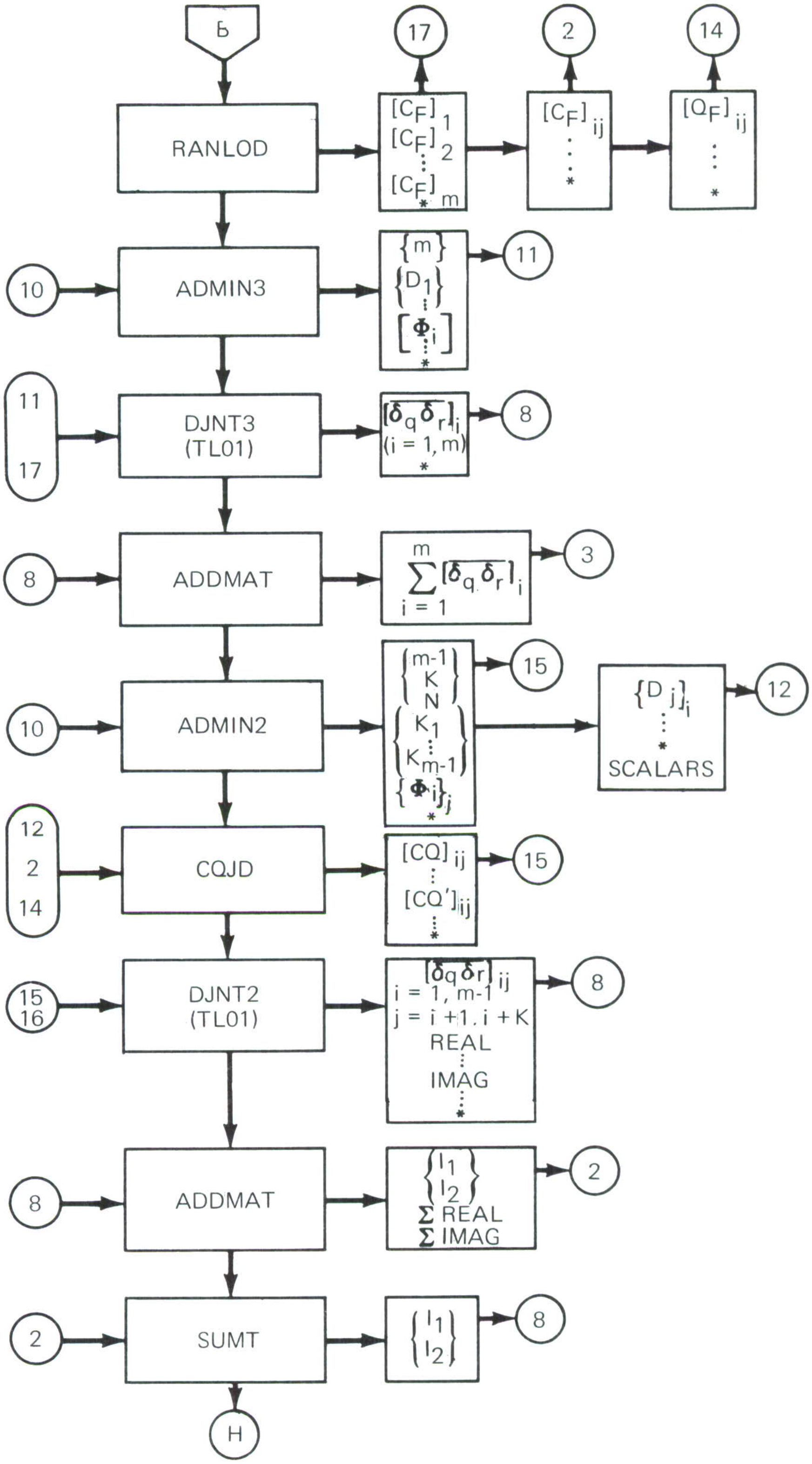

START
READ FREQUENCIES AND GENERALIZED MASSES FROM TAPE 10.
READ λ, μ, g, N, K, & NF.
FORWARD–SPACE MASTER TAPE UNIT 9 TO READ CORRECT TL01 SUBROUTINES (TAPOS).
READ FREQUENCIES FROM CARDS IF CPSD IS DESIRED.
WHAT OPTION IS DESIRED ?
OPTION 1
A
OPTION 3
IS CPSD OR JD DESIRED ?
CPSD
E
JD
D
OPTION 2
IS CPSD OR JD DESIRED ?
JD
B
CPSD
C
EXIT

Figure 43. RANSO Flow Diagrams


A
RANLOD
[Q*F] [CF] AT ω'S *
17
10
PEDAN
15
[R]1 [R]1 [R]2 [R]2 [R]NF [R]NF *
16
[R]1 [R]2 [R]NF *
14
N N2 + 3 NF m n *
14 15 16
COMINV (TL01)
12
* [L]1 [J]1 * * [L]NF [J]NF *
12 14 17
CPSD1 (TL01)
15
[R]i (i = 1, NF)
16
[I]j (j = 1, NF)
SCRATCH
3
15 16
PRINTA
10 14 15 16
SRESP1 (TL01)
[S]1 REAL (1,NF)
[S]1 IMAG (1,NF)
[S]n REAL (1,NF)
[S]n IMAG (1,NF)
3
3
PRINT B
CONS
C1 C2 CNF
4
4 14 16
TRAPM (TL01)
NF Σ i=1 [R]i
NF Σ i=1 [I]i
12
12
PRINTC
10 12 14
SJNT1 (TL01)
STRESS
3
F

NOTE: [R] REAL PART OF A COMPLEX MATRIX (REAL)
[I] IMAGINARY PART OF A COMPLEX MATRIX (IMAG)
C INTEGRATION CONSTANTS
K KPARAM CONSTANTS

Figure 43–Continued



B
RANLOD
$[C_F]_1$
$[C_F]_2$
$[C_F]_m$
$[C_F]_{ij}$
$[Q_F]_{ij}$
17
2
14
ADMIN3
10
$\{m\}$
$\{D_1\}$
$[\Phi_i]$
11
DJNT3
(TL01)
11
17
$[\delta_q \delta_r]_i$
(i = 1, m)
8
ADDMAT
8
$\sum_{i=1}^{m} [\delta_q \delta_r]_i$
3
ADMIN2
10
m-1
K
N
K_1
K_{m-1}
$\{\Phi_i\}_j$
15
$\{D_j\}_i$
SCALARS
12
CQJD
12
2
14
$[CQ]_{ij}$
$[CQ']_{ij}$
15
DJNT2
(TL01)
15
16
$[\delta_q \delta_r]_{ij}$
i = 1, m-1
j = i + 1, i + K
REAL
IMAG
8
ADDMAT
8
I_1
I_2
Σ REAL
Σ IMAG
2
SUMT
2
I_1
I_2
8
H

Figure 43—Continued

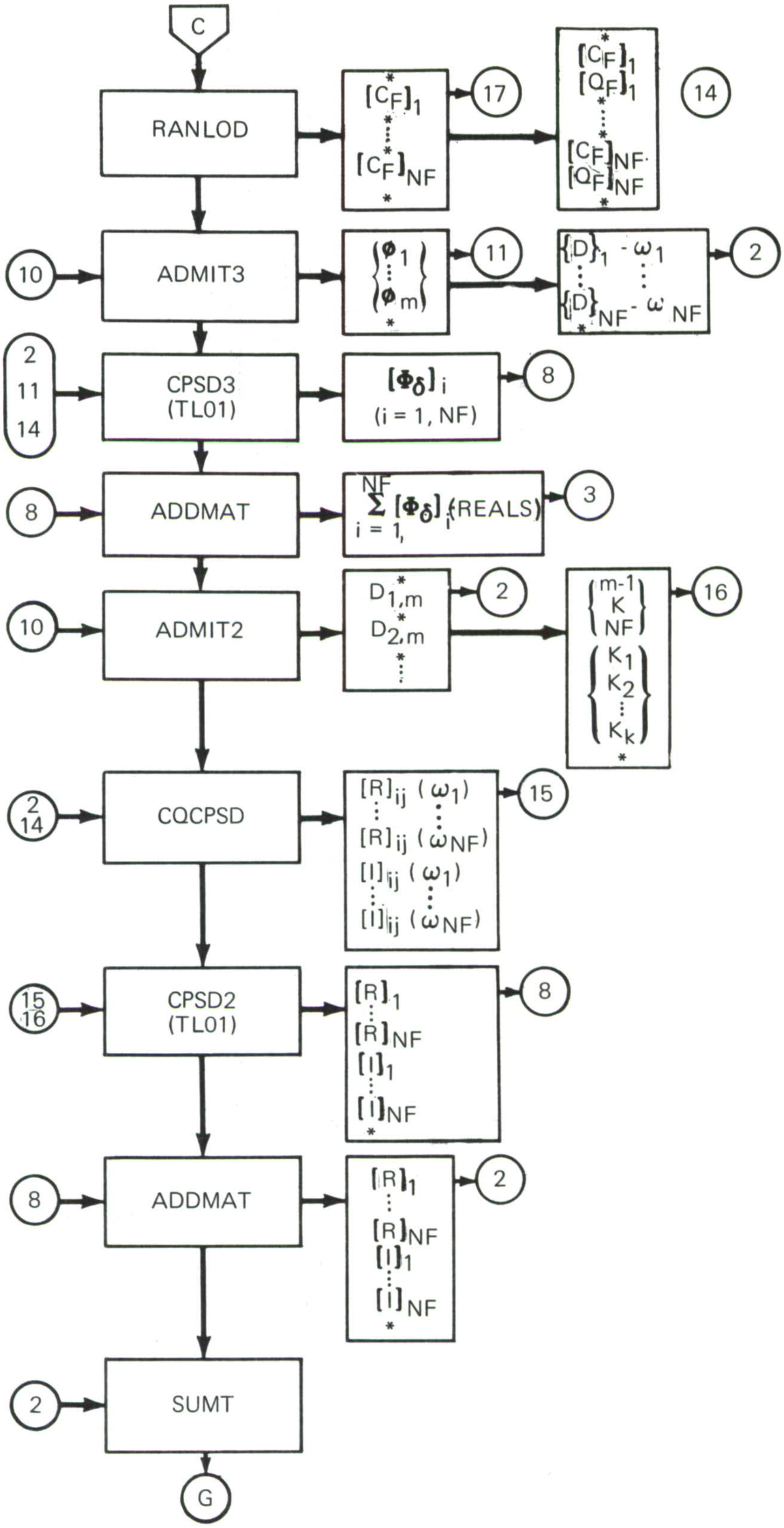

C
RANLOD
ADMIT3
CPSD3
(TL01)
ADDMAT
ADMIT2
CQCPSD
CPSD2
(TL01)
ADDMAT
SUMT
G
17
14
10
11
2
8
3
16
15
(i = 1, NF)
(REALS)

Figure 43–Continued

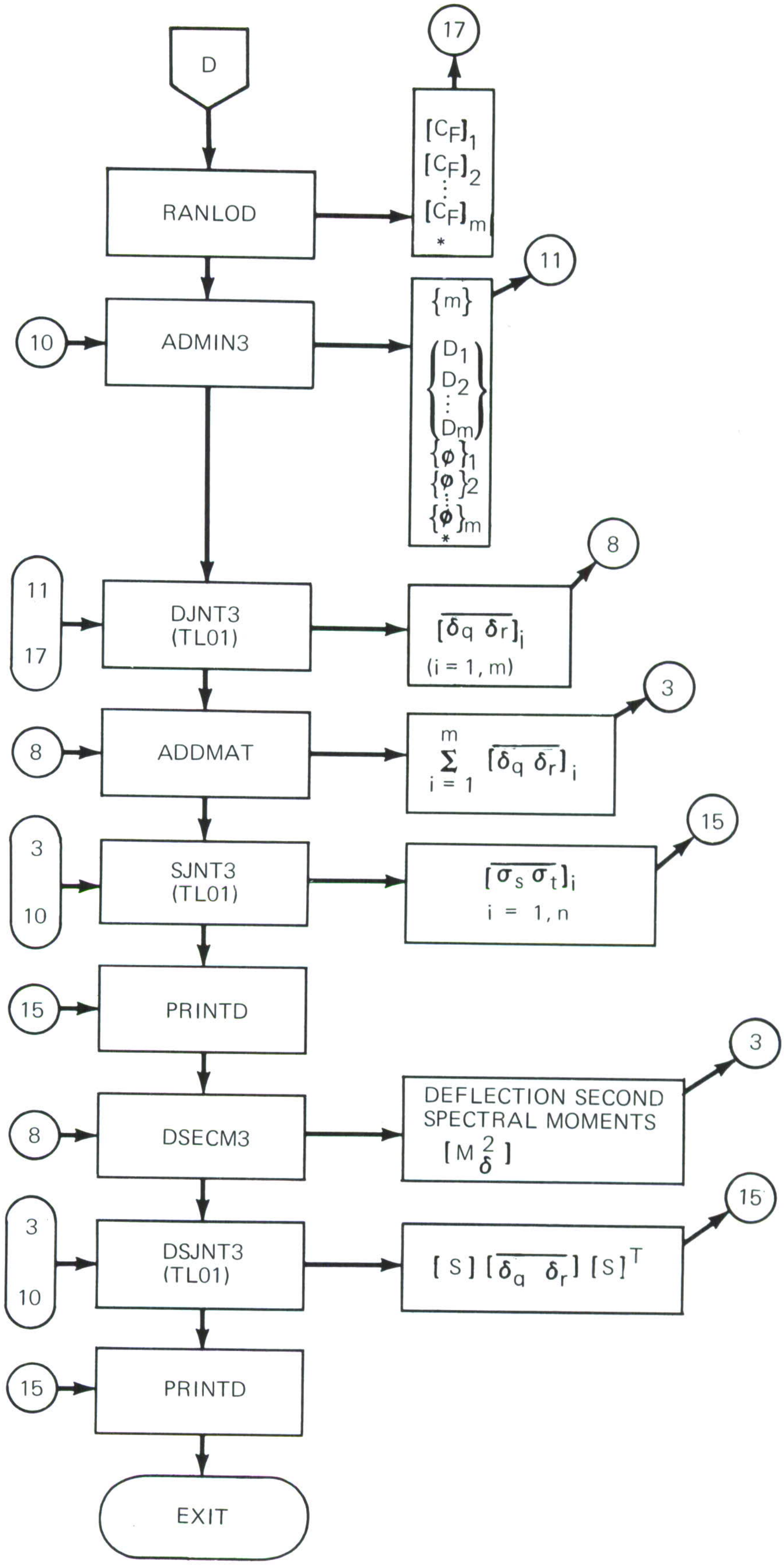
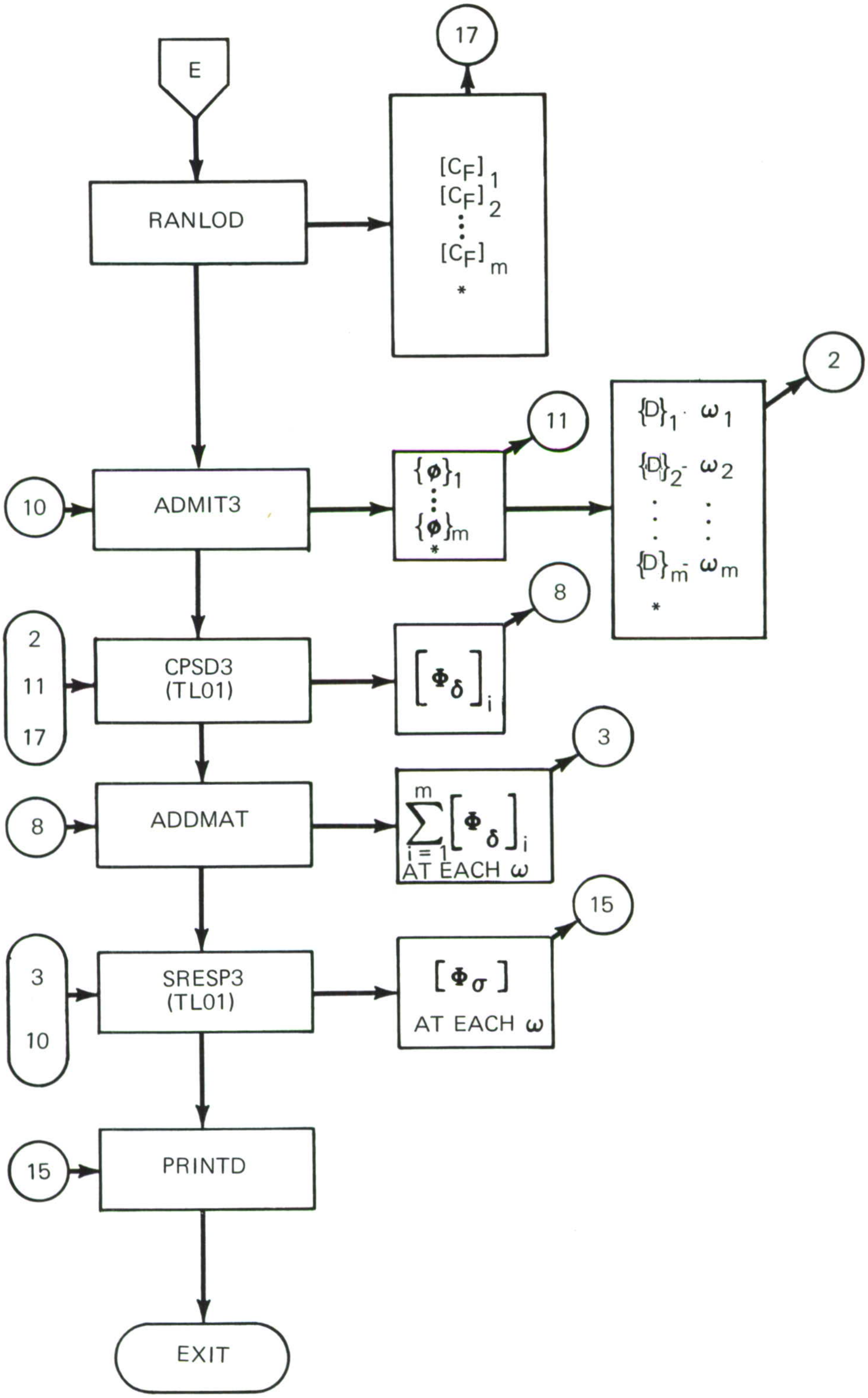

D
RANLOD
$[C_F]_1$
$[C_F]_2$
$[C_F]_m$
*
17
10
ADMIN3
$\{m\}$
$\begin{Bmatrix} D_1 \\ D_2 \\ \vdots \\ D_m \end{Bmatrix}$
$\{\phi\}_1$
$\{\phi\}_2$
$\{\phi\}_m$
*
11
11
17
DJNT3
(TL01)
$[\overline{\delta_q \; \delta_r}]_i$
(i = 1, m)
8
8
ADDMAT
$\sum_{i=1}^{m} [\overline{\delta_q \; \delta_r}]_i$
3
3
10
SJNT3
(TL01)
$[\overline{\sigma_s \; \sigma_t}]_i$
i = 1, n
15
15
PRINTD
8
DSECM3
DEFLECTION SECOND
SPECTRAL MOMENTS
$[M_\delta^2]$
3
3
10
DSJNT3
(TL01)
$[S] [\overline{\delta_q \; \delta_r}] [S]^T$
15
15
PRINTD
EXIT

Fig. 43—Continued



E
RANLOD
[CF]1
[CF]2
[CF]m
*
17
10
ADMIT3
{φ}1
{φ}m
*
11
{D}1 · ω1
{D}2 · ω2
{D}m · ωm
*
2
2
11
17
CPSD3
(TL01)
[Φδ]i
8
8
ADDMAT
Σ i=1 m [Φδ]i
AT EACH ω
3
3
10
SRESP3
(TL01)
[Φσ]
AT EACH ω
15
15
PRINTD
EXIT

Figure 43-Continued

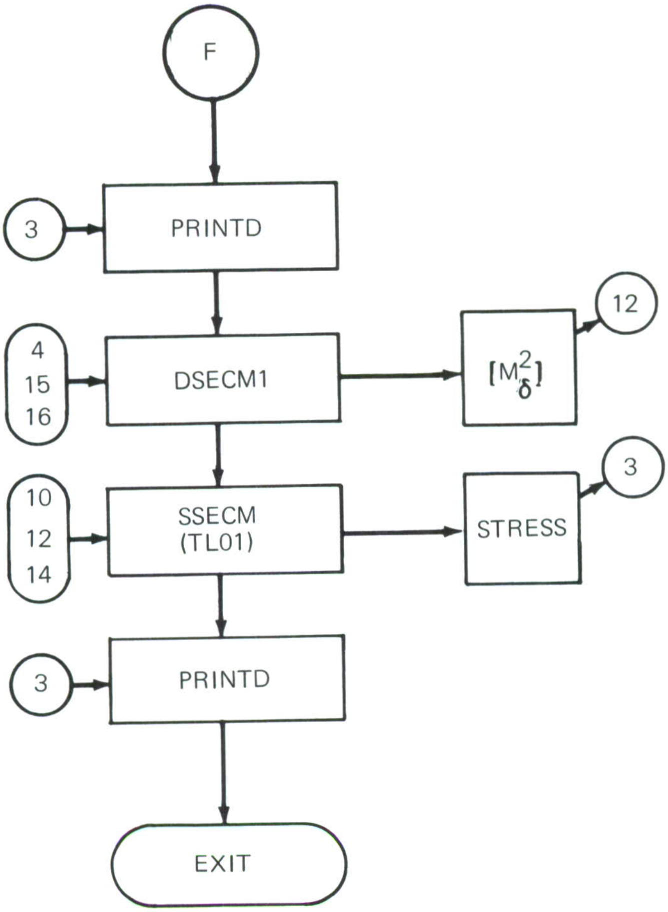

F
3
PRINTD
4
15
16
DSECM1
$[M_\delta^2]$
12
10
12
14
SSECM
(TL01)
STRESS
3
3
PRINTD
EXIT

Figure 43—Continued

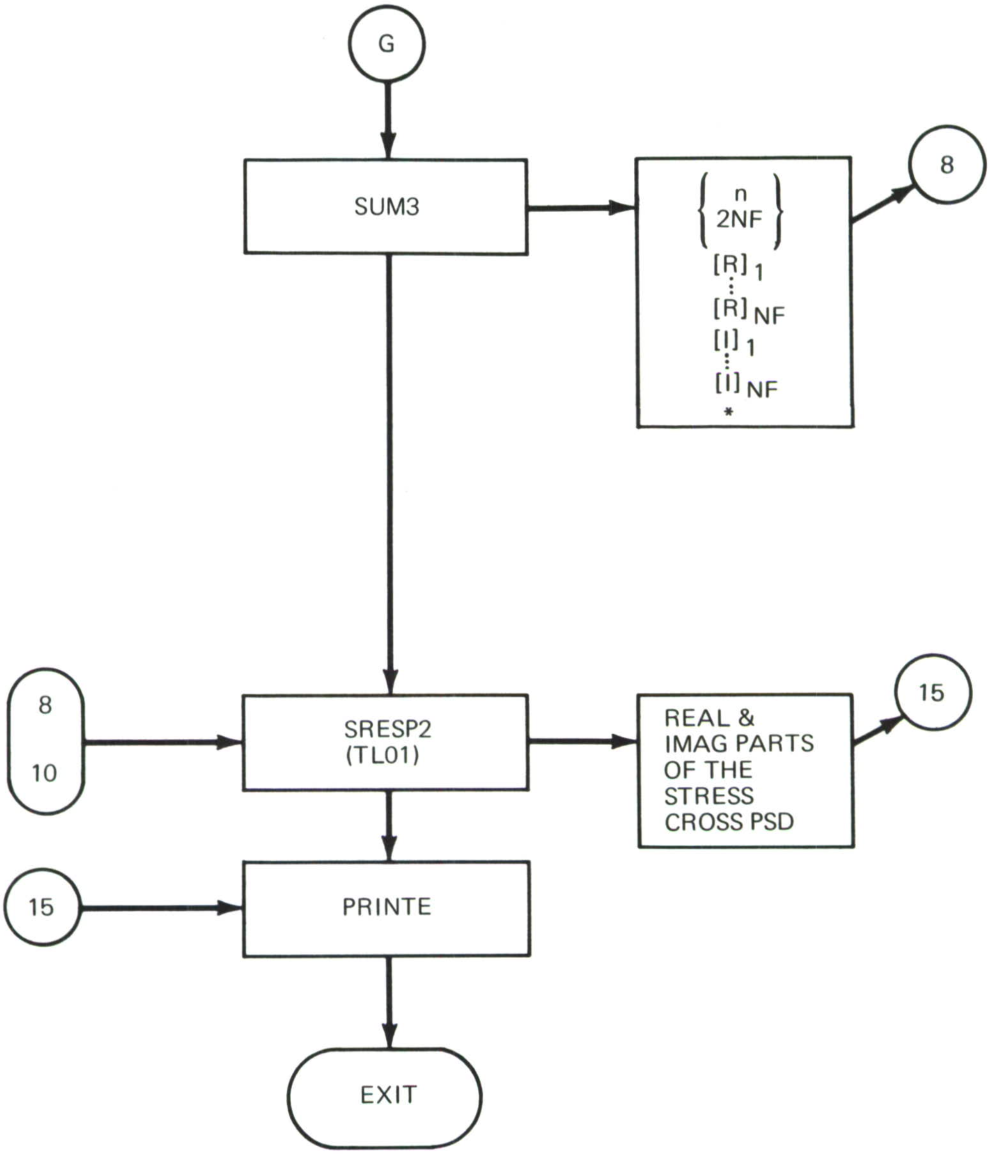
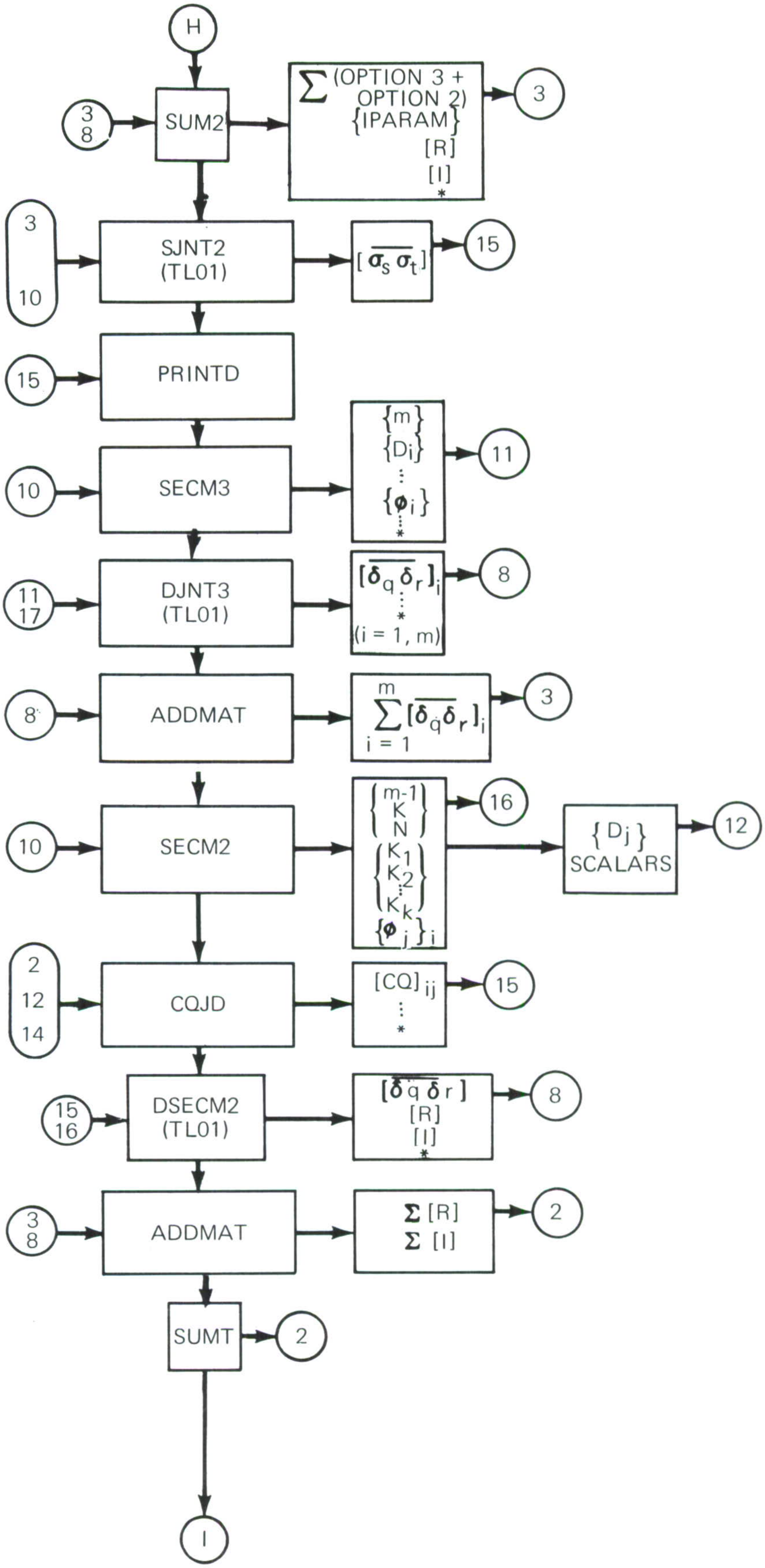

G
SUM3
n
2NF
[R] 1
[R] NF
[I] 1
[I] NF
*
8
8
10
SRESP2
(TL01)
REAL &
IMAG PARTS
OF THE
STRESS
CROSS PSD
15
15
PRINTE
EXIT

Figure 43—Continued



H
3
8
SUM2
Σ (OPTION 3 + OPTION 2)
{IPARAM}
[R]
[I]
*
3
3
10
SJNT2
(TL01)
[σ̄s σ̄t]
15
15
PRINTD
10
SECM3
{m}
{Di}
{φi}
*
11
11
17
DJNT3
(TL01)
[δ̄q δ̄r]i
*
(i = 1, m)
8
8
ADDMAT
m
Σ [δ̄q δ̄r]i
i = 1
3
10
SECM2
{m-1 K N}
{K1 K2 Kk}
{φj}i
16
{Dj}
SCALARS
12
2
12
14
CQJD
[CQ]ij
*
15
15
16
DSECM2
(TL01)
[δ̄q δ̄r]
[R]
[I]
*
8
3
8
ADDMAT
Σ [R]
Σ [I]
2
SUMT
2
I

Figure 43–Continued

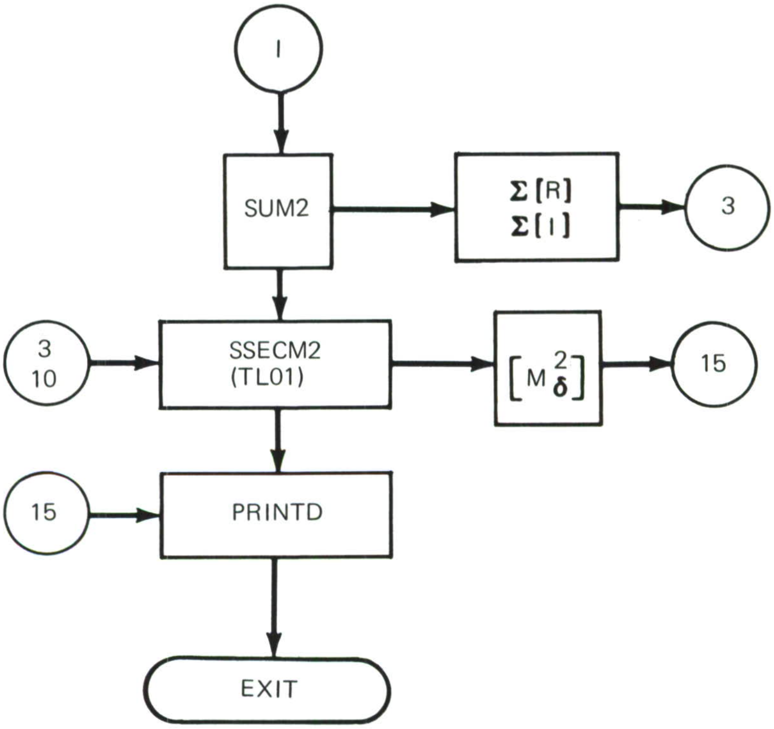


Figure 43–Concluded

(5) RANSO Subroutine Listing

Subroutine	Function
PEDAN	Impedance matrix
CONS	Calculates the constants used in the complex matrix integration using the trapezoidal rule
ADMIN2	Admittance integral scalars used in option 2 deflection covariance calculations
CQJD	Multiplies the co-PSD and quad-PSD matrices by the admittance scalar integrals used in the deflection covariance calculations and sums the products
SECM3	Calculates the scalars in the deflection-spectral-moment equations for option 3

Subroutine	Function
SECM2	Calculates the second-spectral-moment scalars for option 2 deflection covariance
DSECM3	Calculates the deflection second spectral moments for option 3
CQCPSD	Multiplies the co-PSD and quad-PSD matrices by the admittance scalars and sums the products for option 2
ADMIT2	Admittance scalars used in option 2 cross-PSD calculations
ADMIN3	Admittance integral scalars used in option 3 deflection covariance calculations
ADMIT3	Admittance scalars used in option 3 cross-PSD calculations
ADDMAT	Performs the matrix summation for option 2 and option 3 deflection covariance and cross-PSD calculations
TAPOS	Positions the master tape in proper positions to start reading TL01 data for all options
SUM2	Performs the matrix summation for option 2 deflection covariance and cross-PSD calculations
SUM3	Performs the matrix summation for option 3 deflection covariance and cross-PSD calculations
SUMT	Sums the option 2 and option 3 matrices
COMINV	Inverts a complex matrix
CPSD1	Calculates the deflection response cross PSD for option 1
SRESP1	Calculates stress response cross PSD for option 1
TRAPM	Performs the complex matrix integration over all frequencies to form the deflection covariance matrices for option 1
SJNT1	Calculates joint stress cross-PSD matrix for option 1
DSECM1	Calculates deflection second-spectral-moment matrix for option 1
SSECM	Calculates stress second spectral moments for option 1
DJNT3	Calculates deflection covariance matrix for option 3

Subroutine	Function
DJNT2	Calculates deflection covariance matrix for option 2
SJNT2	Calculates stress covariance matrix for option 2
DSECM2	Calculates deflection second-spectral-moment matrix for option 2
CPSD3	Calculates deflection cross-PSD matrix for option 3
CPSD2	Calculates deflection cross PSD for option 2
SJNT3	Calculates stress covariance matrix for option 3
DSJNT3	Calculates stress second-spectral-moment matrix for option 3
SRESP3	Calculates stress cross PSD for option 3
PRINTA	Prints the deflection cross-PSD matrices (option 1)
PRINTB	Prints the stress cross-PSD matrices for plates and beams (option 1)
PRINTC	Prints the deflection covariance matrices (option 1)
PRINTD	Prints the stress cross-PSD matrices in option 3 and prints the stress covariance matrix in all options
PRINTE	Prints the stress cross-PSD matrices (option 2)

b. Option 1 Solution Program—General Viscous Damping

(1) Organization

Option 1 is time consuming, because there is a complex matrix inversion involved for each frequency. When the excitation is not broadband, the mean-square deflections and stresses are calculated by numerical integration.

The damping matrix $[C]$ is card input. The stiffness matrix $[K]$ and the mass matrix $[M]$ come from the phase I output tape. The desired frequencies for which the responses are formed are card inputs.

The solution steps and their associated subroutine names are described below. The limitations are as follows:

$$N \leq 60$$
$$m \leq 25$$
$$NF \leq 60$$

Step 1: The excitation-force matrices co-power $[C_F(\omega_i)]$ and quad-power $[Q_F(\omega_i)]$ spectral densities for each desired frequency are generated using subroutine RANLOD.

Step 2: The impedance matrix is calculated in subroutine PEDAN and is divided into a real part $-\omega^2 [M] + [K]$ and an imaginary part $\omega[C]$. These matrices are used as inputs to the admittance-matrix formation.

Step 3: The admittance matrix $[H(i\omega)]$ is calculated for all frequencies using the impedance matrix as the input. A complex matrix-inversion process is used in the calculation for the admittance matrix at each specified frequency.

The TL01 subroutine COMINV is used to find the complex matrix inverse. See section IV 2.b. (2)(3) for the subroutine flow chart and a description of the method. Thus,

$$[H(i\omega)] = \left|-\omega^2 [M] + i\omega [C] + [K]\right|^{-1}$$

The admittance matrix is divided into a real part $[J(\omega)]$ and an imaginary part $[L(\omega)]$ and is stored on a scratch tape for the cross-PSD solution. Hence,

$$[H(i\omega)] = [J(\omega)] - i\,[L(\omega)]$$

Step 4: The deflection cross-PSD matrices $[\Phi_\delta(\omega)]$ are calculated for all frequencies by TL01 subroutine CPSD1. See section IV 2.b. (2)(j). The real part is formed by use of the relationship:

$$[C_\delta(\omega)] = [J]\left([C_F(\omega)]\,[J] + [Q_F(\omega)]\,[L]\right) + [L]\left([C_F(\omega)]\,[L] - [Q_F(\omega)]\,[J]\right)$$

The imaginary part is formed by use of the relationship:

$$[Q_\delta(\omega)] = [L]\left([C_F(\omega)]\,[J] + [Q_F(\omega)]\,[L]\right) - [J]\left([C_F(\omega)]\,[L] - [Q_F(\omega)]\,[J]\right)$$

The cross PSD calculated at each frequency is stored on tape for later use in the deflection second-spectral-moment calculation.

Step 5: If the stress cross-PSD solution is desired, TL01 subroutine SRESP1 is used. Thus,

$$[\Phi_\sigma(\omega)] = [S] \; [\Phi_\delta(\omega)] \; [S]^T$$

The stress matrices [S] come from the phase I output tape and the cross PSD $[\Phi_\delta(\omega)]$ are formed in step 4 above. See section IV 2. b. (2) (f).

Step 6: If the deflection covariances are desired, the cross PSD's are numerically integrated using the trapezoidal rule. To obtain a desired accuracy, an adequate number of cross PSD's should be defined over the frequency range. The constants used in the trapezoidal method are calculated in subroutine CONS, section IV 2. b. (2)(c), and stored on tape. These scalar constants are multiplied by the N-by-N cross-PSD matrices and summed over the frequency range to calculate the deflection covariance in TL01 subroutine TRAPM. See section IV 2.b.(2)(g).

Step 7: If the stress covariance matrices are desired, TL01 subroutine SJNT1 is used. See section IV 2. b. (2)(h). Thus,

$$[\overline{\sigma_s \sigma_t}] = [S] \; [\overline{\delta_q \delta_r}] \; [S]^T$$

Step 8: The deflection second spectral moments are obtained by multiplying the cross PSD formed in step 4 by the square of the frequency and by constants from CONS and then summing over all frequencies. This is accomplished in subroutine DSECM1. See section IV 2. b. (2) (d).

Step 9: The stress second spectral moments are calculated in TL01 subroutine SSECM, section IV 2. b. (2) (i), by using the N-by-N matrix calculation in step 8. This matrix is premultiplied by the stress matrix [S] and postmultiplied by $[S]^T$.

(2) Subroutine Descriptions

(a) Subroutine RANLOD (Refer to section IV 1.)

(b) Subroutine PEDAN (figure 44)

Method: The impedance real and imaginary matrices are calculated for NF frequencies.

- Real part: $-\omega^2\ [M] + [K]$
- Imaginary part: $\omega [C]$

Input: Mass matrix $[M]$ and the stiffness matrix $[K]$ come from the phase I output tape. The damping matrix $[C]$ is card input.

Output: The impedance matrices (real part and imaginary part) are stored on a scratch tape.

Error: Standard READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Argument list: None

Length: 40526_8

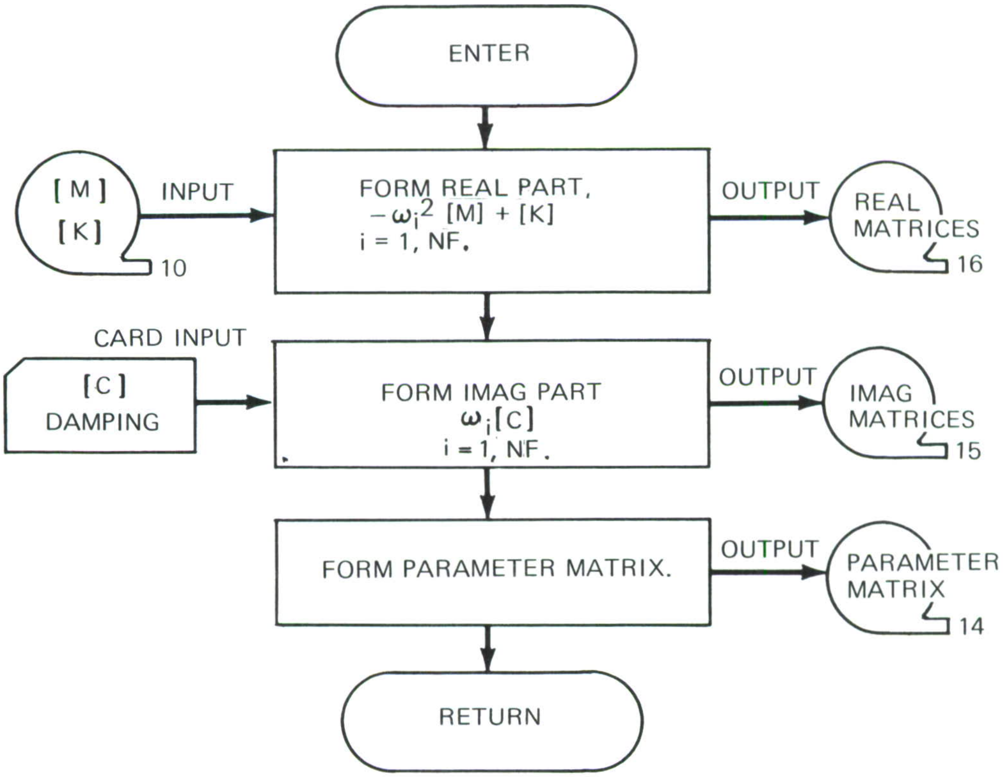

ENTER
[M]
[K]
10
INPUT
FORM REAL PART,
$-\omega_i^2\ [M] + [K]$
i = 1, NF.
OUTPUT
REAL MATRICES
16
CARD INPUT
[C]
DAMPING
FORM IMAG PART
$\omega_i [C]$
i = 1, NF.
OUTPUT
IMAG MATRICES
15
FORM PARAMETER MATRIX.
OUTPUT
PARAMETER MATRIX
14
RETURN

Figure 44. PEDAN Flow Chart

(c) Subroutine CONS (figure 45)

Method: This subroutine calculates the constants C used in the trapezoidal TL01 subroutine TRAPM at NF frequencies (ω_i) .

Form $H_i = \omega_{i+1} - \omega_i$, where $i = 1, NF-1$

Hence, $C_i = \frac{(H_{i-1} + H_i)}{2}$, where $i = 2, NF-1$

and $C_1 = \frac{H_1}{2}$, $C_{NF} = \frac{H_{(NF-1)}}{2}$

Input: Frequencies ω_i are stored in labeled common.

Output: Constants $C_i (i = 1, NF)$ are written on a scratch tape.

Error: Standard WRTETP error messages

Subroutines required: WRTETP

Argument list: None

Length: 526_8

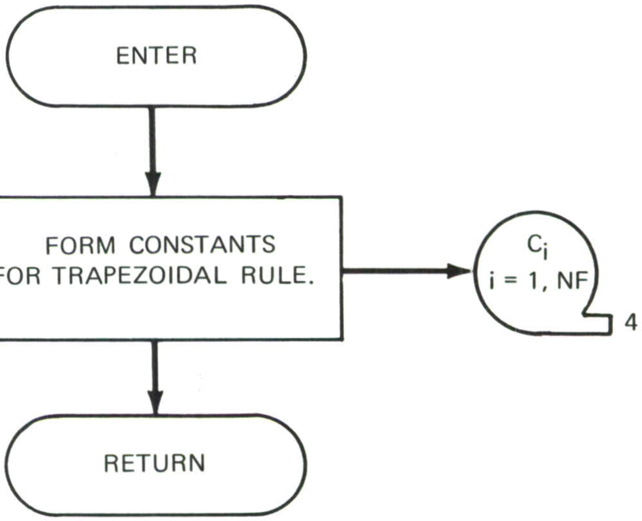

ENTER
FORM CONSTANTS FOR TRAPEZOIDAL RULE.
C_i
i = 1, NF
4
RETURN

Figure 45. CONS Flow Chart

(d) Subroutine DSECM1 (figure 46)

Method: The deflection second spectral moments are calculated by multiplying the cross PSD found in subroutine CPSD1 by $\omega_i^2 C_i$. Thus,

$$\left[M_\delta{}^2\right] = \sum_{i=1}^{m} [\Phi_\delta(i\omega_i)]\ \omega_i{}^2\ C_i$$

Input: Constants C_i and cross-PSD matrices $[\Phi_\delta(i\omega_i)]$ come from a scratch tape.

Output: Deflection second spectral moments are stored on tape 12.

Error: Standard READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Argument list: None

Length: 40514_8

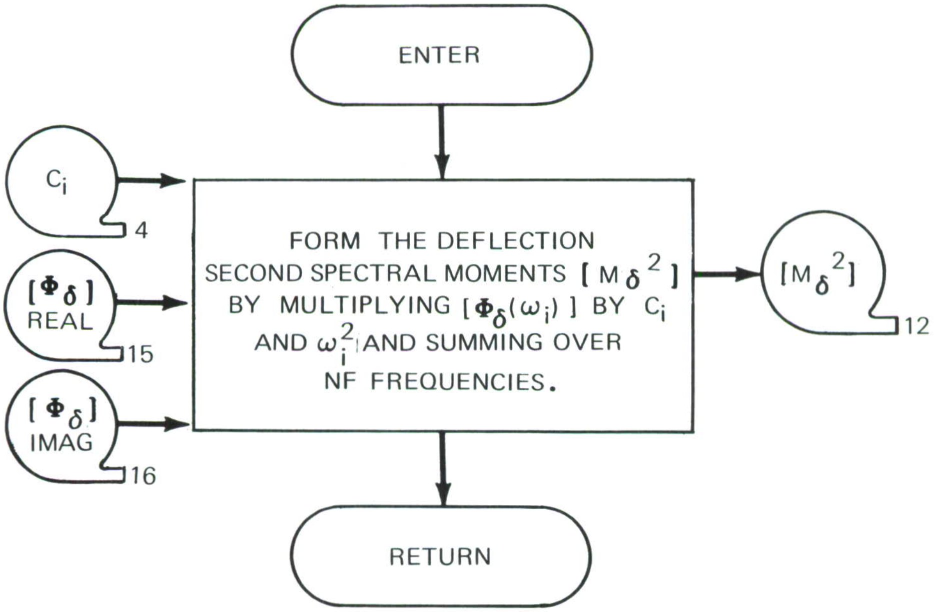

ENTER
C_i
4
$[\Phi_\delta]$ REAL
15
$[\Phi_\delta]$ IMAG
16
FORM THE DEFLECTION SECOND SPECTRAL MOMENTS $[M_\delta{}^2]$ BY MULTIPLYING $[\Phi_\delta(\omega_i)]$ BY C_i AND ω_i^2 AND SUMMING OVER NF FREQUENCIES.
$[M_\delta{}^2]$
12
RETURN

Figure 46. DSECM1 Flow Chart

(e) TL01 Subroutine COMINV

Solve for

$$[C] = ([A] - i\,[B])^{-1} \; .$$

The real part can be expressed as

$$([A] + [B]\,[A]^{-1}\,[B])^{-1}$$

and the imaginary part as

$$-\,[A]^{-1}\,[B]\left([A] + [B]\,[A]^{-1}\,[B]\right)^{-1} \; .$$

where: A = real part of a complex matrix
B = imaginary part of a complex matrix

The flow chart for the complex matrix-inversion subroutine is shown in figure 47.

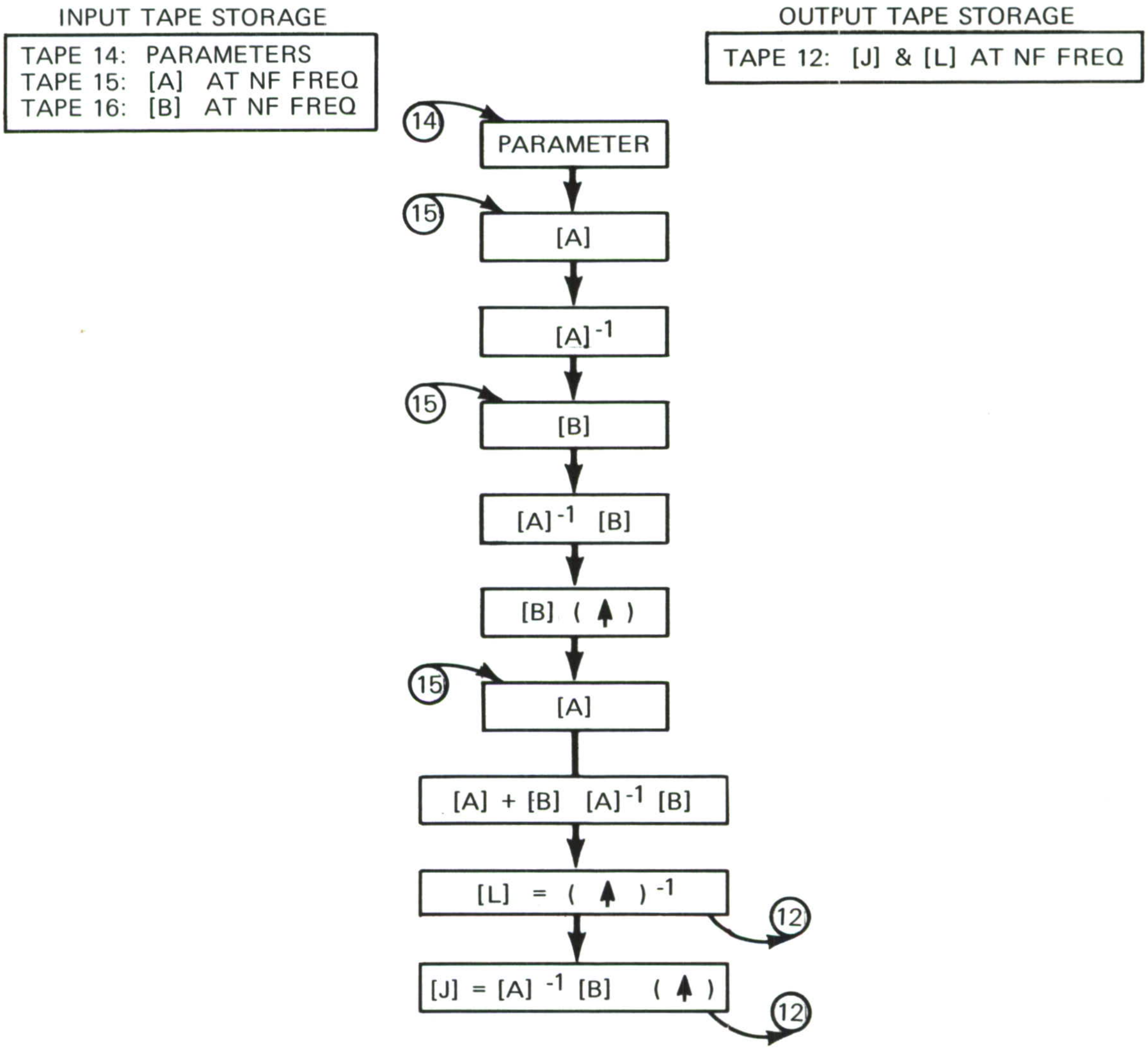

INPUT TAPE STORAGE
TAPE 14: PARAMETERS
TAPE 15: [A] AT NF FREQ
TAPE 16: [B] AT NF FREQ
OUTPUT TAPE STORAGE
TAPE 12: [J] & [L] AT NF FREQ
14
PARAMETER
15
[A]
[A]$^{-1}$
15
[B]
[A]$^{-1}$ [B]
[B] (↑)
15
[A]
[A] + [B] [A]$^{-1}$ [B]
[L] = (↑)$^{-1}$
12
[J] = [A]$^{-1}$ [B] (↑)
12

Figure 47. COMINV Flow Chart

(f) TL01 Subroutine SRESP1

The stress response cross-PSD matrices $[\Phi_\sigma(i\omega)]$ are calculated as shown in figure 48.

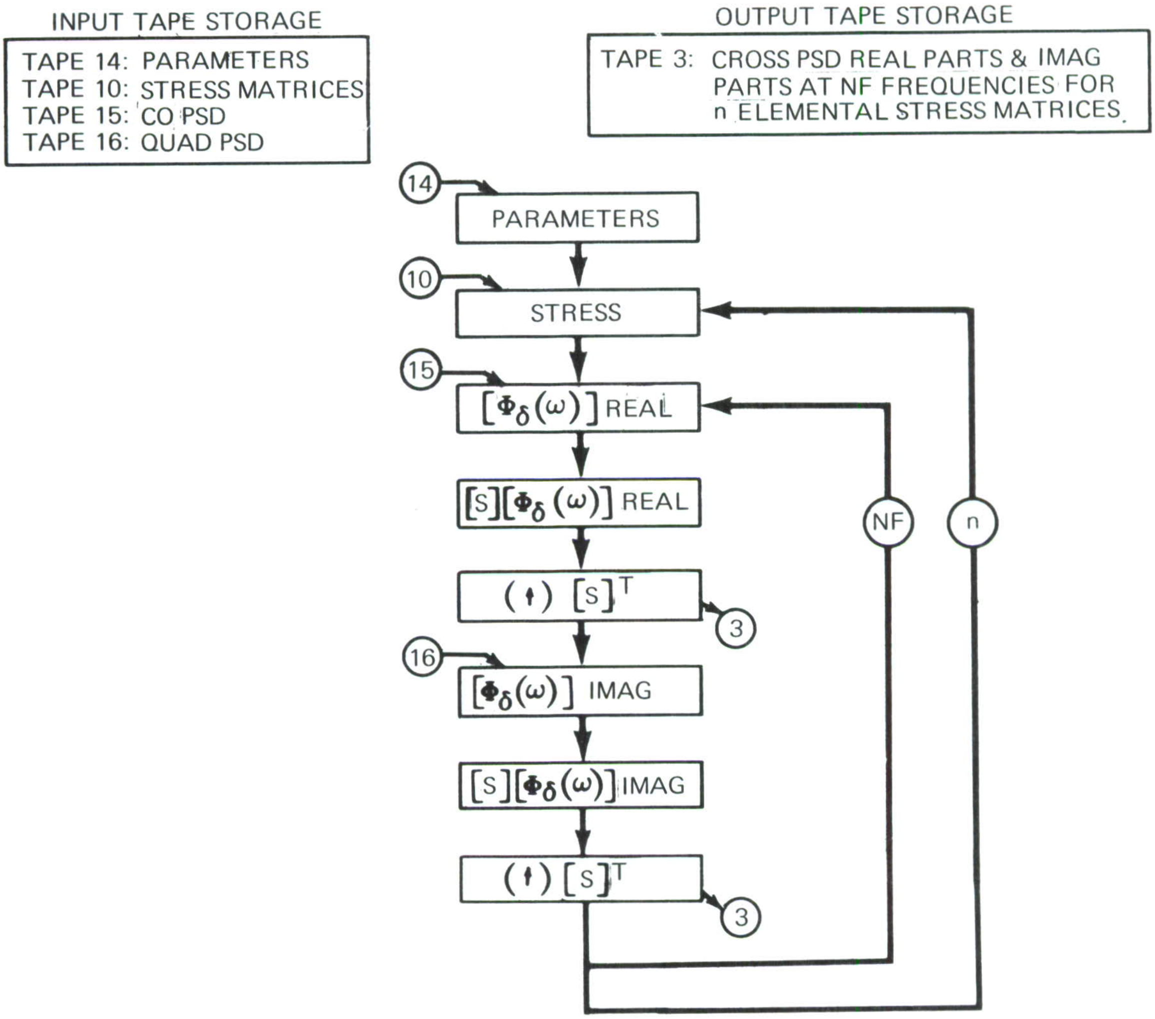

INPUT TAPE STORAGE
TAPE 14: PARAMETERS
TAPE 10: STRESS MATRICES
TAPE 15: CO PSD
TAPE 16: QUAD PSD
OUTPUT TAPE STORAGE
TAPE 3: CROSS PSD REAL PARTS & IMAG PARTS AT NF FREQUENCIES FOR n ELEMENTAL STRESS MATRICES
14
PARAMETERS
10
STRESS
15
$[\Phi_\delta(\omega)]$ REAL
$[S][\Phi_\delta(\omega)]$ REAL
$(\dagger)\ [S]^T$
3
16
$[\Phi_\delta(\omega)]$ IMAG
$[S][\Phi_\delta(\omega)]$ IMAG
$(\dagger)\ [S]^T$
3
NF
n

Figure 48. SRESP1 Flow Chart

(g) TL01 Subroutine TRAPM

The deflection covariance matrix $[\overline{\delta_q \delta_r}]$ is found by integrating the cross-PSD $[\Phi_\delta(i\omega)]$ matrices over NF frequencies by the trapezoidal method. Refer to figure 49.

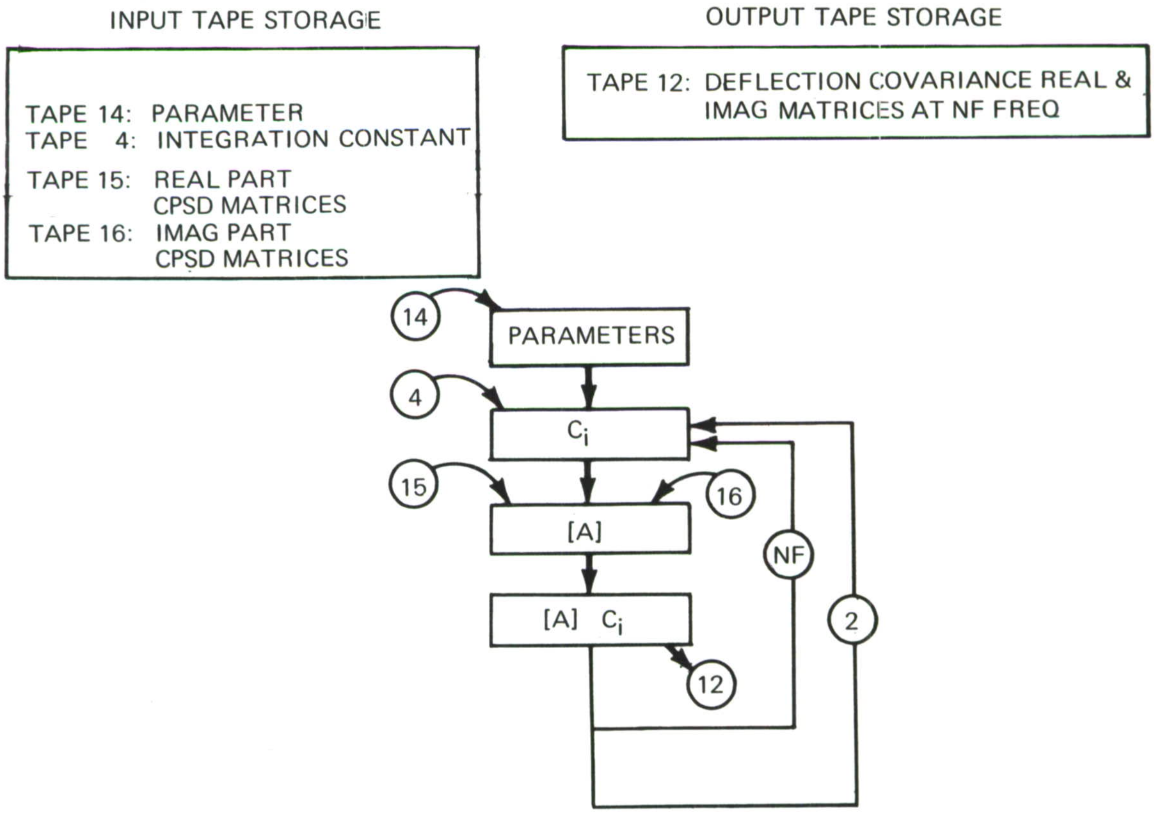

INPUT TAPE STORAGE
TAPE 14: PARAMETER
TAPE 4: INTEGRATION CONSTANT
TAPE 15: REAL PART CPSD MATRICES
TAPE 16: IMAG PART CPSD MATRICES
OUTPUT TAPE STORAGE
TAPE 12: DEFLECTION COVARIANCE REAL & IMAG MATRICES AT NF FREQ
14
PARAMETERS
4
C_i
15
16
[A]
NF
[A] C_i
2
12

Figure 49. TRAPM Flow Chart

(h) TL01 Subroutine SJNT1

The stress covariance matrix $[\overline{\sigma_s \sigma_t}]$ at NF frequencies is calculated as shown in figure 50.

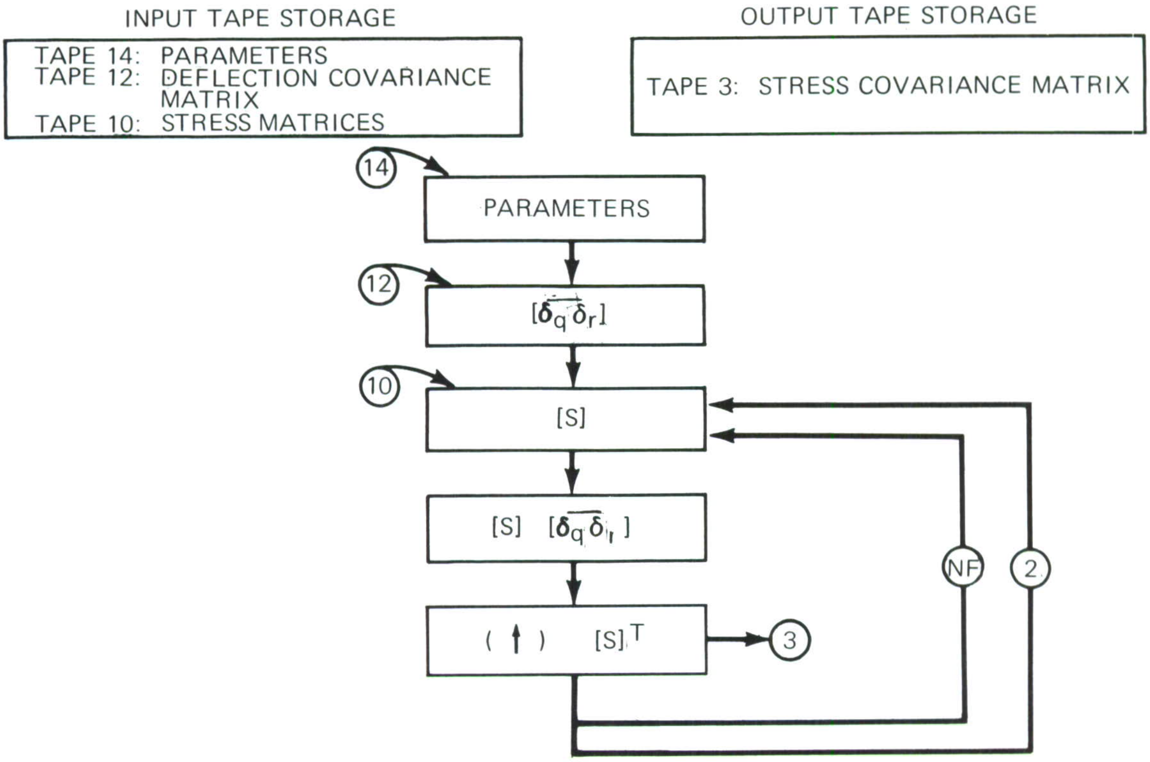

INPUT TAPE STORAGE
TAPE 14: PARAMETERS
TAPE 12: DEFLECTION COVARIANCE MATRIX
TAPE 10: STRESS MATRICES
OUTPUT TAPE STORAGE
TAPE 3: STRESS COVARIANCE MATRIX
14
PARAMETERS
12
$[\overline{\delta_q \delta_r}]$
10
[S]
[S] $[\overline{\delta_q \delta_r}]$
(↑) $[S]^T$
3
NF
2

Figure 50. SJNT1 Flow Chart

(i) TL01 Subroutine SSECM

The stress second-spectral-moment matrix is calculated as shown in figure 51.

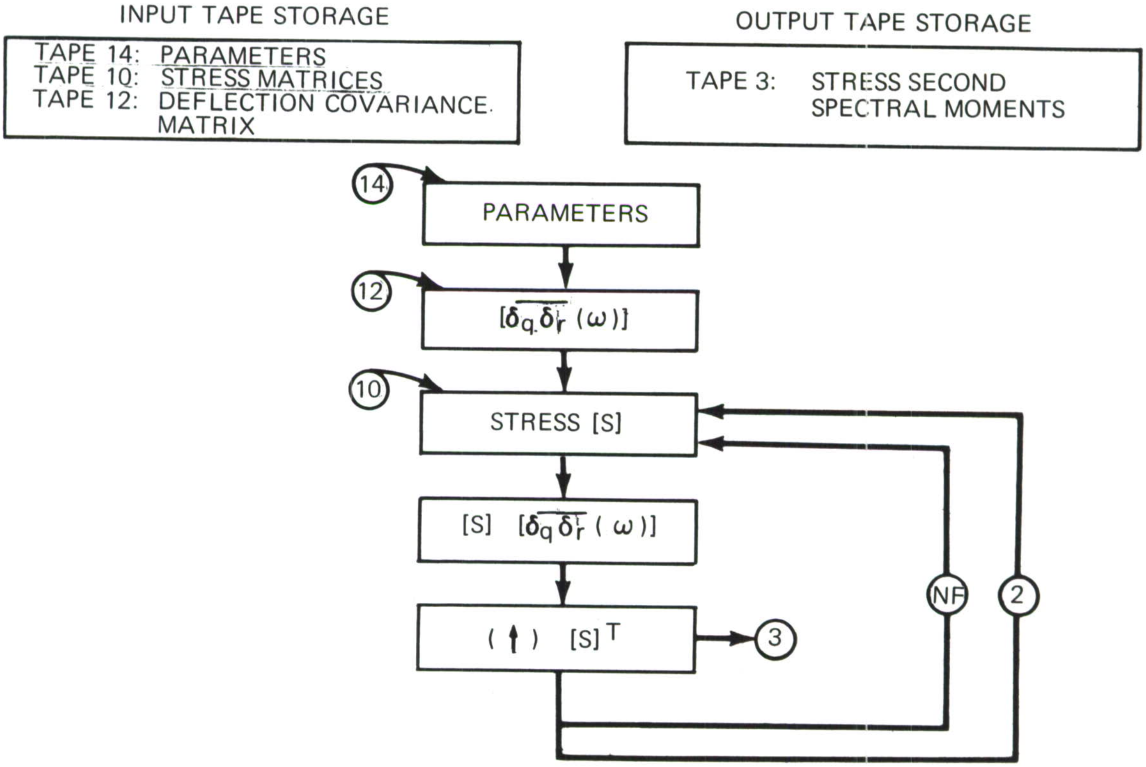

INPUT TAPE STORAGE
TAPE 14: PARAMETERS
TAPE 10: STRESS MATRICES
TAPE 12: DEFLECTION COVARIANCE MATRIX
OUTPUT TAPE STORAGE
TAPE 3: STRESS SECOND SPECTRAL MOMENTS
14
PARAMETERS
12
$[\overline{\delta_q \delta_r^T}(\omega)]$
10
STRESS [S]
[S] $[\overline{\delta_q \delta_r^T}(\omega)]$
(↑) $[S]^T$
3
NF
2

Figure 51. SSECM Flow Chart

(j) TL01 Subroutine CPSD1

The deflection response cross-PSD matrices are calculated for option 1. Refer to figure 52.

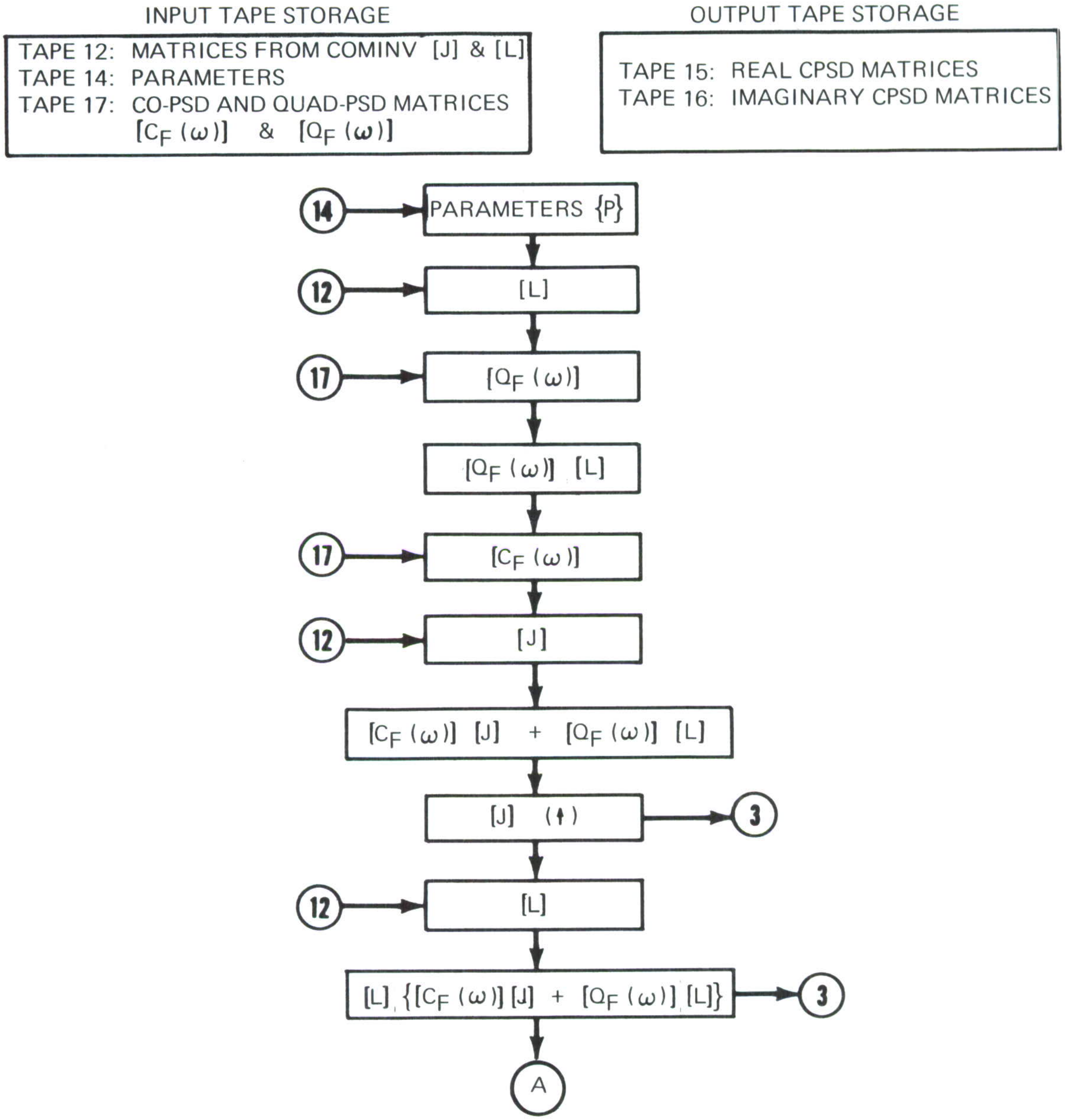

INPUT TAPE STORAGE
TAPE 12: MATRICES FROM COMINV [J] & [L]
TAPE 14: PARAMETERS
TAPE 17: CO-PSD AND QUAD-PSD MATRICES
[C_F (ω)] & [Q_F (ω)]
OUTPUT TAPE STORAGE
TAPE 15: REAL CPSD MATRICES
TAPE 16: IMAGINARY CPSD MATRICES
14
PARAMETERS {P}
12
[L]
17
[Q_F (ω)]
[Q_F (ω)] [L]
17
[C_F (ω)]
12
[J]
[C_F (ω)] [J] + [Q_F (ω)] [L]
[J] (↑)
3
12
[L]
[L] {[C_F (ω)] [J] + [Q_F (ω)] [L]}
3
A

Figure 52. CPSD1 Flow Chart

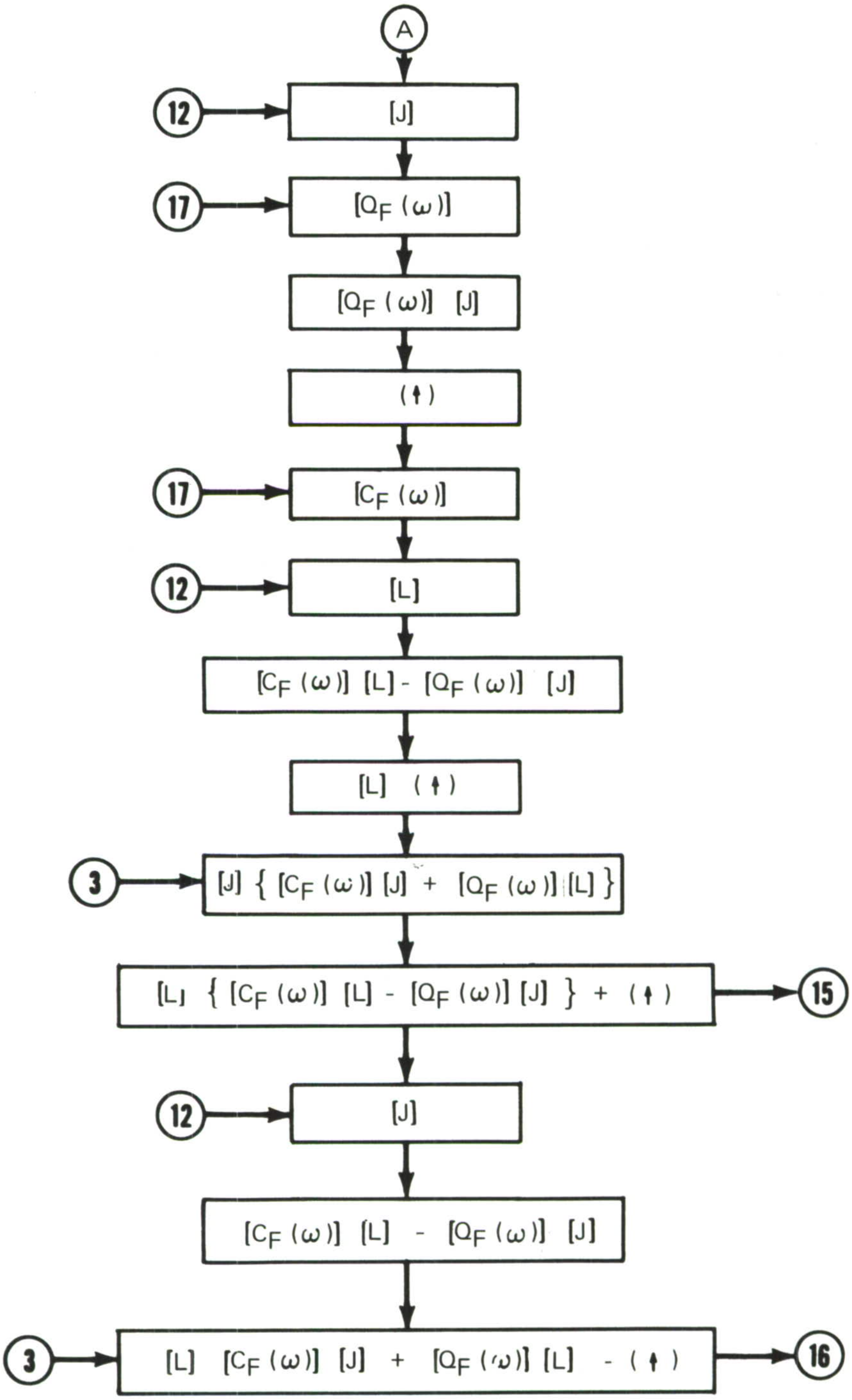

A
12
[J]
17
$[Q_F(\omega)]$
$[Q_F(\omega)]\ [J]$
$(\uparrow)$
17
$[C_F(\omega)]$
12
[L]
$[C_F(\omega)]\ [L] - [Q_F(\omega)]\ [J]$
$[L]\ (\uparrow)$
3
$[J]\ \{[C_F(\omega)]\ [J] + [Q_F(\omega)]\ [L]\}$
$[L]\ \{[C_F(\omega)]\ [L] - [Q_F(\omega)]\ [J]\} + (\uparrow)$
15
12
[J]
$[C_F(\omega)]\ [L] - [Q_F(\omega)]\ [J]$
3
$[L]\ [C_F(\omega)]\ [J] + [Q_F(\omega)]\ [L] - (\uparrow)$
16

Figure 52. —Concluded

c. Option 2 Solution Program—Normal Modes

(1) Organization

The solution of option 2 is divided into two segments: (1) covariance, and (2) cross PSD. For simplicity , each segment is divided into a part that calculates contributions from like modes (same as option 3 and identified as option 3) and a part that calculates contributions from unlike modes. The summation of the like and unlike modal contributions results in the option 2 solution.

The effects of some of the cross modal terms are insignificant. A parameter K can be specified that limits the number of cross modal terms retained in the calculation of the solution. Cross PSD's are generated in two sets. The first set is for the natural frequencies and the second set is for the cross-modal terms. Frequencies for the cross modal term are in the order

$$\omega_{ij} = \frac{\omega_i + \omega_j}{2};$$

where: $i = 1, 2 \ldots, m - 1$

$j = i + 1, \ldots, i + K \leq m$

K = an input parameter defining the number of cross terms in the calculation

m = number of natural frequencies

The limitations are as follows:

$$N \leq 90$$
$$m \leq 25$$
$$NF \leq 90$$
$$1 \leq K \leq m - 1$$

(a) Segment 1—Deflection Covariance

Step 1: The excitation co-PSD (real part) and quad-PSD (imaginary part) matrices are generated in subroutine RANLOD. The excitations are calculated for like and unlike modes.

Step 2: The admittance integral scalars for option 3 are calculated in subroutine ADMIN3. See section IV 2. d. (2)(b).

Step 3: The deflection covariance matrices for like modes are generated in TL01 subroutine DJNT3, section IV 2. d. (2)(f), for each normal mode. In subroutine ADDMAT, section IV 2. d. (2)(c), the deflection covariance matrices are summed over m normal modes.

Step 4: The admittance integral scalars are calculated in subroutine ADMIN2, section IV 2. c. (2)(c). If a parameter K is specified, there are K cross-product terms of the admittance integral scalars formed for each mode.

Step 5: In subroutine CQJD, section IV 2. c. (2)(e), the excitations calculated in step 1 are combined with the admittance integral scalars calculated in step 4, and the resultant matrices are stored on a scratch tape that is used in deflection covariance subroutine DJNT2. See section IV 2. c. (2)(m).

Step 6: The deflection covariance for K cross terms for each mode are calculated in TL01 subroutine DJNT2. Real and imaginary parts of the deflection covariance matrices are generated for each cross mode and stored on scratch tape. Subroutine ADDMAT sums all the cross-modal deflection covariance matrices for the real and imaginary parts.

Step 7: The real part of the matrix calculated in step 6 is added to its transpose to form the real part of the deflection covariance matrix. The imaginary part of the matrix calculated in step 6 is added to its negative transpose to form the imaginary part of the deflection covariance matrix. This is done in subroutine SUMT. See section IV 2. c. (2)(f).

Step 8: The deflection covariance matrices of like and unlike modes are calculated in subroutine SUM2, section IV 2. c. (2)(g). This subroutine adds contributions from like modes obtained in option 3 to contributions from the unlike modes obtained in option 2.

Step 9: The stress covariance matrices are generated in TL01 subroutine SJNT2, section IV 2. c. (2)(n). The deflection covariance matrices (real and imaginary parts) are premultiplied by $[S]$ and postmultiplied by $[S]^T$.

Step 10: The second-spectral-moment scalars of option 3 are calculated in subroutine SECM3. See section IV 2. c. (2)(h).

Step 11: The second-spectral-moment matrices for like modes (same as in option 3) are calculated in TL01 subroutine DJNT3, section IV 2. d. (2)(f), for each mode and stored on tape. Subroutine ADDMAT takes the m deflection second-spectral-moment matrices and sums for the normal modes.

Step 12: The scalars from the integrals used in the second spectral moments are calculated in subroutine SECM2, section IV 2. c. (2)(i), for like and unlike modes.

Step 13: The excitation matrices are combined with the scalars (same as in step 5 with different scalar values) in subroutine CQJD, and the resultant matrices are stored on scratch tape.

Step 14: The deflection second spectral moments are generated in TL01 subroutine DSECM2, section IV 2. c. (2)(o), for each cross mode. Subroutine ADDMAT is used to sum the deflection second-spectral-moment matrices over m unlike modes.

Step 15: The real matrix calculated in step 14 is added to its transpose to form the real part of the deflection second-spectral-moment matrix. The imaginary part of the matrix calculated in step 14 is added to its negative transpose to form the real part of the deflection second-spectral-moment matrix. This is done in subroutine SUMT.

Step 16: The summation of the deflection second-spectral-moment matrix results from contributions from both like and unlike modes for the real and imaginary parts as done in subroutine SUM2.

Step 17: The calculation of the stress second-spectral-moment matrix for real and imaginary parts is done in TL01 subroutine SSECM2. See section IV 2. c. (2)(p).

(b) Segment 2—Cross-PSD Solution

Step 1: Excitation co-PSD and quad-PSD matrices are generated in subroutine RANLOD for each frequency. The option 3 excitation co-PSD matrices are also calculated for each frequency. The NF selected frequencies are card input.

Step 2: The admittance scalars are calculated in subroutine ADMIT3 for each frequency. See section IV 2. d. (2)(e).

Step 3: The like-mode contributions to the deflection cross-PSD matrix solutions are generated in TL01 subroutine CPSD3. See section IV 2. d. (2)(i).

Step 4: The like-mode contributions to the deflection cross-PSD matrix solutions calculated in step 3 are summed in subroutine ADDMAT over m normal modes for each NF frequency.

Step 5: The admittance scalars are calculated in subroutine ADMIT2, section IV 2. c. (2)(j), for each frequency. If a parameter K is specified, there are K cross-product scalars formed at each mode for each frequency.

Step 6: In subroutine CQCPSD, section IV 2. c. (2)(k), the excitations calculated in step 1 are combined with the admittance scalars calculated in step 5 for each frequency, and the resultant matrices are stored on scratch tape.

Step 7: A component of each of the deflection co- and quad-PSD matrices is calculated at each mode for NF frequencies in TL01 subroutine CPSD2. See section IV 2. c. (2)(q). The ADDMAT subroutine is used to sum the cross-modal matrices for each mode at NF frequencies.

Step 8: The component co-PSD matrix calculated in step 7 is added to its transpose to form the deflection co-PSD matrix. The component quad-PSD matrix calculated in step 7 is added to its negative transpose to form the deflection quad-PSD matrix. There are NF co- and quad-PSD solutions for cross-modal contributions. This is done in subroutine SUMT.

Step 9: Subroutine SUM3 sums matrices obtained in steps 4 and 8 to obtain the deflection cross-PSD matrices.

Step 10: The stress cross PSD is generated in TL01 subroutine SRESP2. See section IV 2. c. (2)(v).

(2) Subroutine Descriptions

(a) Subroutine RANLOD (Refer to section IV 1.)

(b) Subroutines ADMIN3, ADDMAT, DJNT3, ADMIT3, and CPSD3 (See the subroutine descriptions for option 3, section IV 2. d. (2).)

(c) Subroutine ADMIN2

This subroutine (figure 53) calculates and stores on tape the admittance integral scalars used in the calculation of deflection covariance.

Method: The admittance integral scalars

$$\int_0^\infty D_i\, E_i\, d\omega, \quad \int_0^\infty D_j\, E_i\, d\omega$$

and

$$\int_0^\infty (D_i\, D_j + E_i\, E_j)\, d\omega$$

are combined in the following manner:

$$DE_{ij} = \int_0^\infty D_i\, E_j\, d\omega - \int_0^\infty D_j\, E_i\, d\omega$$

$$ED_{ij} = \int_0^\infty D_j\, E_i\, d\omega - \int_0^\infty D_i\, E_j\, d\omega$$

$$DDEE_{ij} = \int_0^\infty (D_i\, D_j + E_i\, E_j)\, d\omega$$

where: $i = 1,\ m - 1$

$j = i + 1,\ i + K \leq m$

See the Engineering User's Guide, reference 3, for definitions of the integrals.

Input: Mode shapes from phase I output tape

Output: Admittance integral scalars are stored on tape.

Error: READTP/WRTETP error messages

Subroutines required: READTP/WRTETP, SCALE

Length: 15301_8

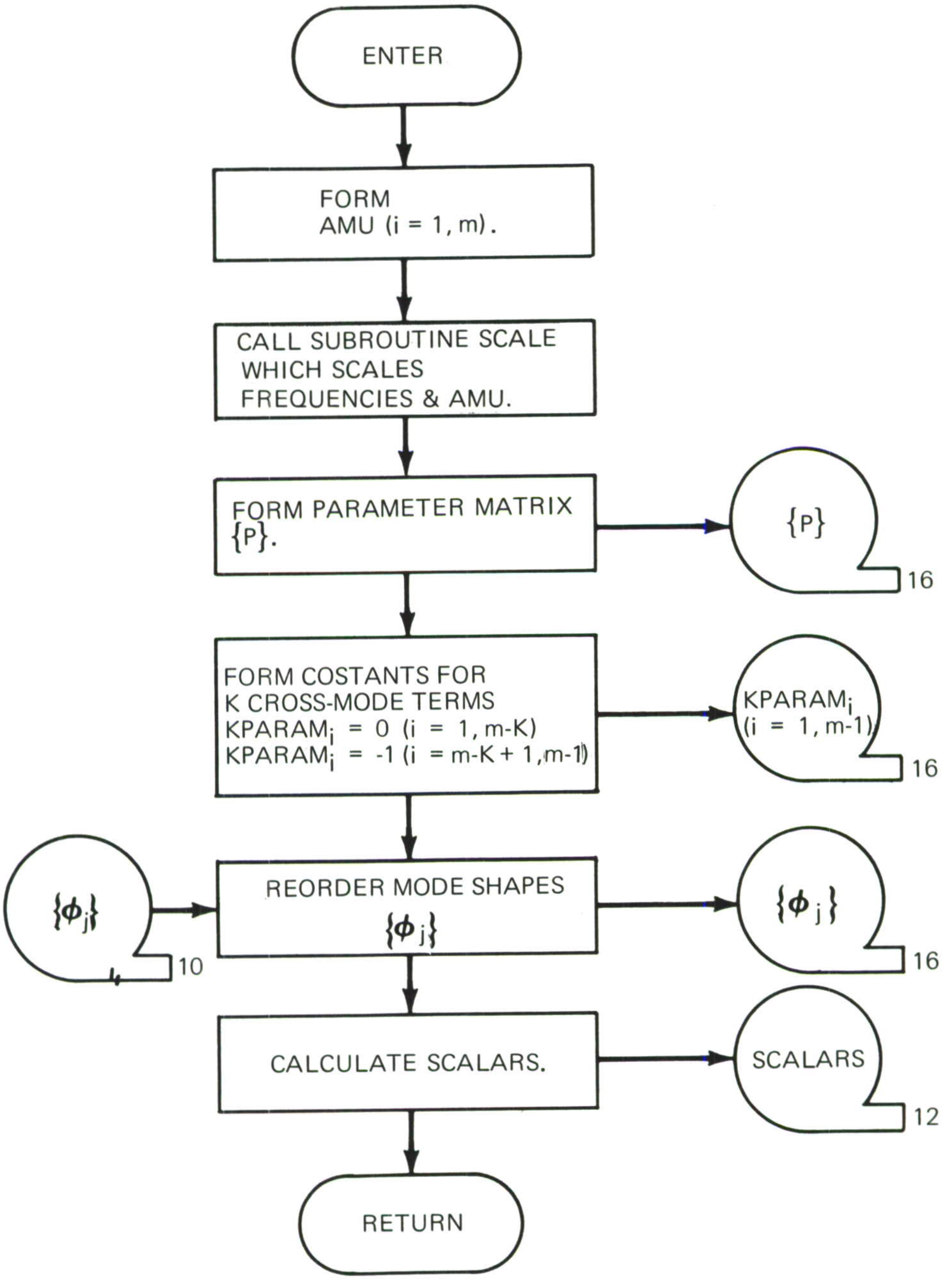

ENTER
FORM
AMU (i = 1, m).
CALL SUBROUTINE SCALE
WHICH SCALES
FREQUENCIES & AMU.
FORM PARAMETER MATRIX
{P}.
{P}
16
FORM COSTANTS FOR
K CROSS-MODE TERMS
KPARAM$_i$ = 0 (i = 1, m-K)
KPARAM$_i$ = -1 (i = m-K + 1, m-1)
KPARAM$_i$
(i = 1, m-1)
16
{ϕ_j}
10
REORDER MODE SHAPES
{ϕ_j}
{ϕ_j}
16
CALCULATE SCALARS.
SCALARS
12
RETURN

Figure 53. ADMIN2 Flow Chart

(d) Subroutine SCALE

This subroutine (figure 54) examines the magnitude of the first natural frequency and then uses an appropriate factor to scale frequencies.

Method: This subroutine will only scale frequencies ω from 0 to 100,000 Hz. If

$$0 \le \omega \le 100$$
$$100 < \omega \le 1,000$$
$$1,000 < \omega \le 10,000$$
$$10,000 < \omega \le 100,000$$

the scale factors are

10
100
1,000
10,000 respectively.

Input: Frequencies and m

Output: Scale factor and the scaled frequencies

Argument list:
FREQ = frequencies
M = number of mode shapes
SCAL = scale factor

Length: 105_8

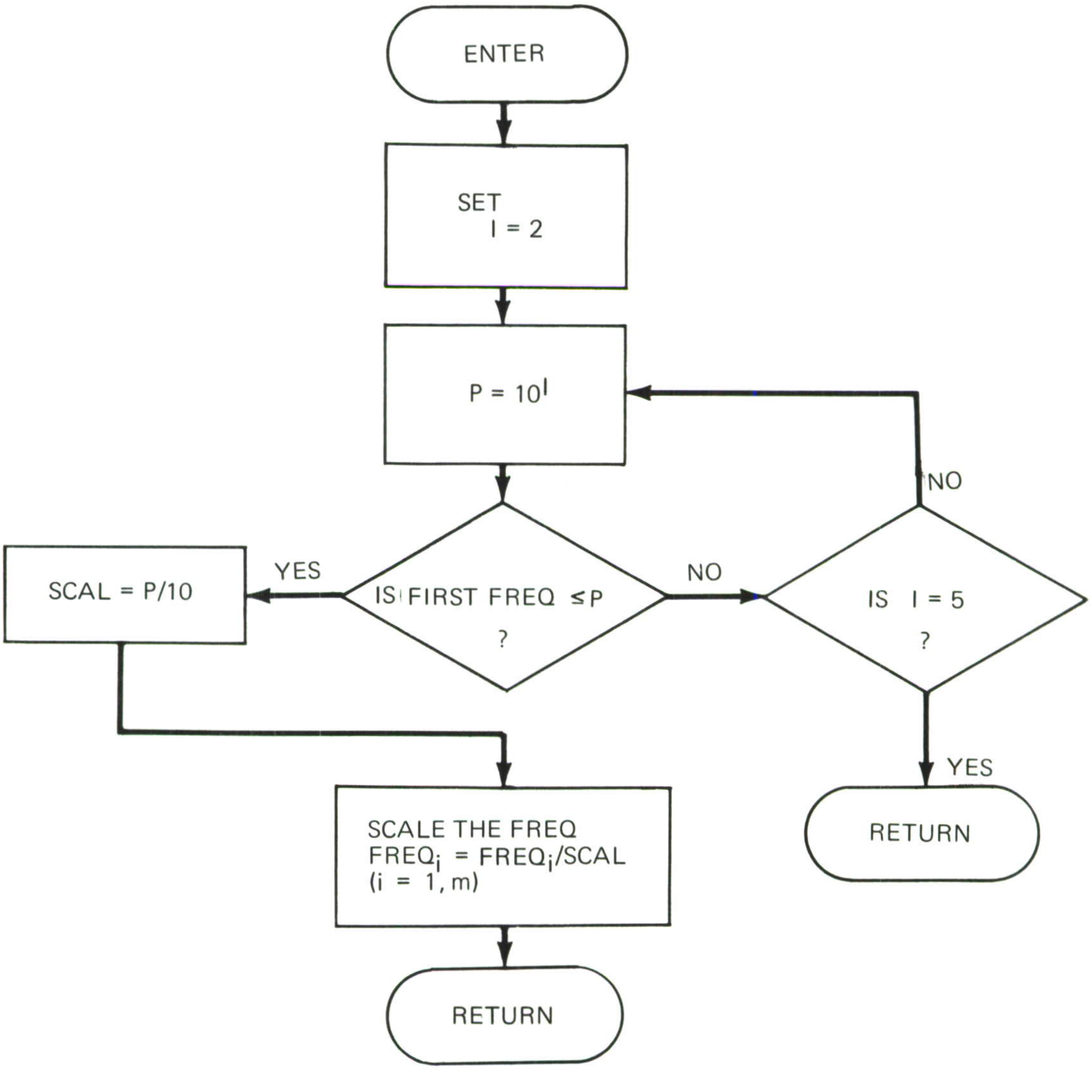

ENTER
SET
I = 2
P = 10^I
IS FIRST FREQ ≤ P
?
YES
NO
SCAL = P/10
IS I = 5
?
NO
YES
SCALE THE FREQ
FREQ_i = FREQ_i/SCAL
(i = 1, m)
RETURN
RETURN

Figure 54. SCALE Flow Chart

(e) Subroutine CQJD

This subroutine (figure 55) combines the excitation co-power $[C_F(\omega)]$ and quad-power $[Q_F(\omega)]$ spectral density matrices and the admittance integral scalars when calculating the deflection covariance.

Method: A component of the deflection co-PSD is

$$[CQ]_{ij} = \alpha_{ij} \; [C_F]_{ij} + \gamma_{ij} \; [Q_F]_{ij}$$

A component of the deflection quad-PSD is

$$[CQ']_{ij} = - \gamma_{ij} \; [C_F]_{ij} + \alpha_{ij} \; [Q_F]_{ij}$$

where: $\alpha_{ij} = \int_0^\infty (D_i \, D_j + E_i \, E_j) \, d\omega$

$$\gamma_{ij} = \int_0^\infty D_i \, E_j \, d\omega - \int_0^\infty D_j \, E_i \, d\omega$$

$i = 1, \; m - 1$

$j = i + 1, \; i + K$

Input: Admittance integral scalars and the excitation co- and quad-PSD matrices from tape

Output: The $[CQ]_{ij}$ and $[CQ']_{ij}$ matrices are outputs on tape

Error: READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Length: 40300_8

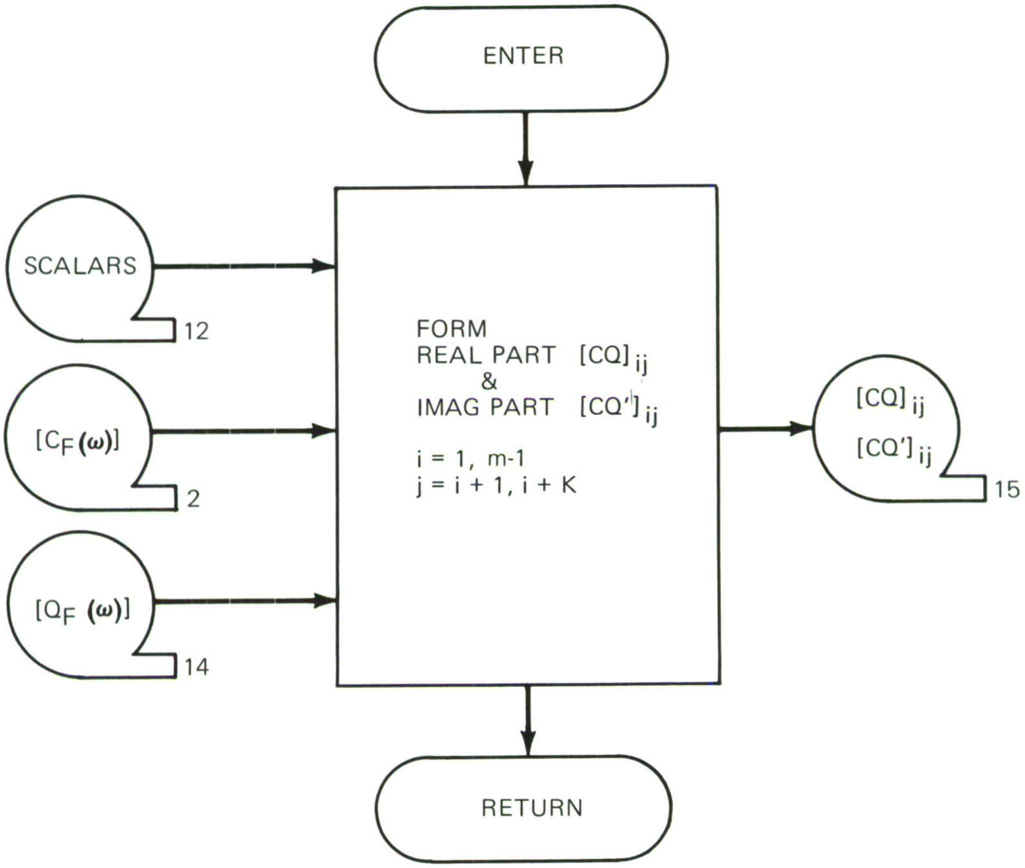

ENTER
SCALARS
12
$[C_F(\omega)]$
2
$[Q_F(\omega)]$
14
FORM
REAL PART $[CQ]_{ij}$
&
IMAG PART $[CQ']_{ij}$
$i = 1, m-1$
$j = i + 1, i + K$
$[CQ]_{ij}$
$[CQ']_{ij}$
15
RETURN

Figure 55. CQJD Flow Chart

(f) Subroutine SUMT

This subroutine (figure 56) sums a matrix with its transpose matrix.

Method: A matrix [A] is read from tape. The transpose of this matrix is added to itself, and the resultant matrix is the real part of the deflection covariance. To form the corresponding imaginary part, the transpose of this matrix is subtracted from itself. For the deflection cross-PSD calculations, this operation is repeated NF times, one for each frequency. For the real part,

$$[A] + [A]^T$$

and for the imaginary part,

$$[A] - [A]^T$$

Input: Tape input of matrices

Output: Tape output of the final deflection covariance or cross-PSD matrices

Error: READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Length: 40247_8

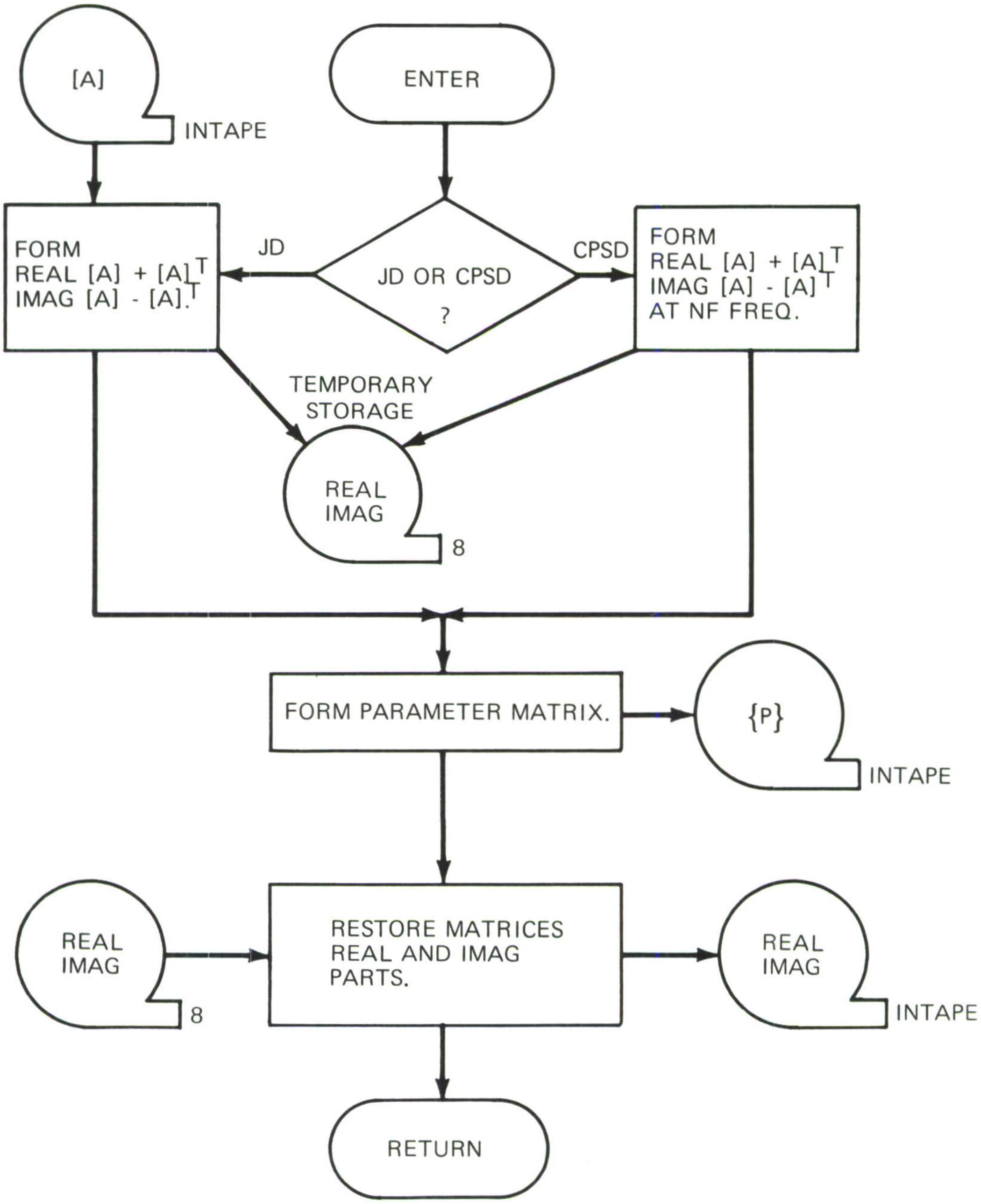

[A]
INTAPE
ENTER
JD OR CPSD
?
JD
CPSD
FORM
REAL [A] + [A]T
IMAG [A] - [A].T
FORM
REAL [A] + [A]T
IMAG [A] - [A]T
AT NF FREQ.
TEMPORARY STORAGE
REAL
IMAG
8
FORM PARAMETER MATRIX.
{P}
INTAPE
REAL
IMAG
8
RESTORE MATRICES REAL AND IMAG PARTS.
REAL
IMAG
INTAPE
RETURN

Figure 56. SUMT Flow Chart

(g) Subroutine SUM2

Method: This subroutine (figure 57) sums contributions to the real part of the deflection covariance matrix from like and unlike modes. The result is stored on an output tape.

The imaginary part of the deflection covariance matrix is transferred from its input tape to the output tape. Contributions come from only the unlike modes.

Input: Deflection covariance matrices for like modes stored on ITP1

Output: The deflection covariance matrices including contributions from like and unlike modes. This is stored on tape ITP1.

Error: READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Argument list: ITP1—Option 3 like-mode contributions to the deflection covariance matrices are stored on tape ITP1.

ITP2—Option 2 unlike-mode contributions to the deflection covariance matrices (real and imaginary parts) are stored on tape ITP2.

NO—If NO = 1, then calculate option 3
If NO = 2, then calculate option 2

NCN—If NCN = 1, then sum the deflection covariance matrices
If NCN = 2, then sum the deflection second spectral moment matrices

Length: 40370_8

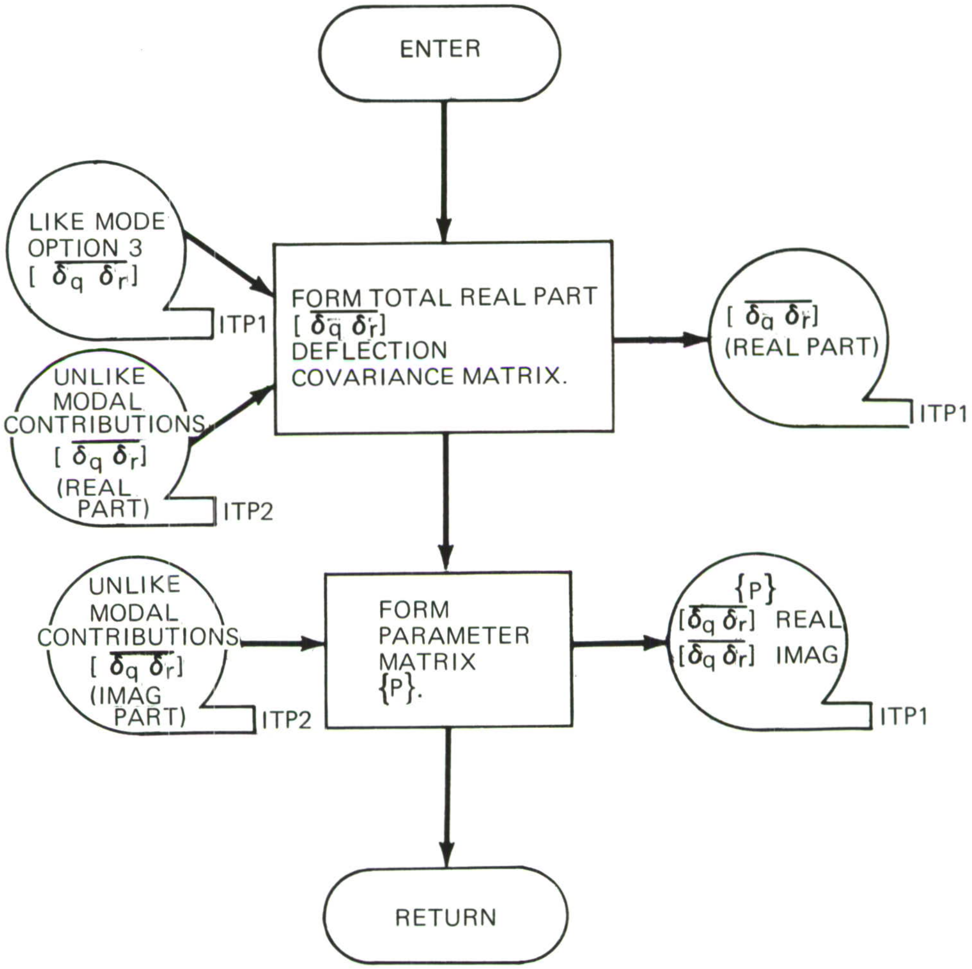

ENTER
LIKE MODE OPTION 3 $[\overline{\delta_q \delta_r}]$
ITP1
UNLIKE MODAL CONTRIBUTIONS $[\overline{\delta_q \delta_r}]$ (REAL PART)
ITP2
FORM TOTAL REAL PART $[\overline{\delta_q \delta_r}]$ DEFLECTION COVARIANCE MATRIX.
$[\overline{\delta_q \delta_r}]$ (REAL PART)
ITP1
UNLIKE MODAL CONTRIBUTIONS $[\overline{\delta_q \delta_r}]$ (IMAG PART)
ITP2
FORM PARAMETER MATRIX $\{P\}$.
$\{P\}$
$[\overline{\delta_q \delta_r}]$ REAL
$[\overline{\delta_q \delta_r}]$ IMAG
ITP1
RETURN

Figure 57. SUM2 Flow Chart

(h) Subroutine SECM3

This subroutine (figure 58) calculates the admittance integral scalars used in the deflection second spectral moments. The subroutine also reads mode shapes from the phase I output tape and restores them on another tape.

Method: $\left[M_\delta{}^2\right] = \pi/\left(2\mu_i\, M_i^2\right)$

where: $\mu_i = \mu + \lambda\omega_i^2 + g\,\omega_i$

$i = 1,\ m$

Input: Mode shapes $\{\varphi_i\}$ come from phase I output tape.

Output: A parameter matrix, admittance integral scalars, and modes stored on tape.

Error: READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Length: 5423_8

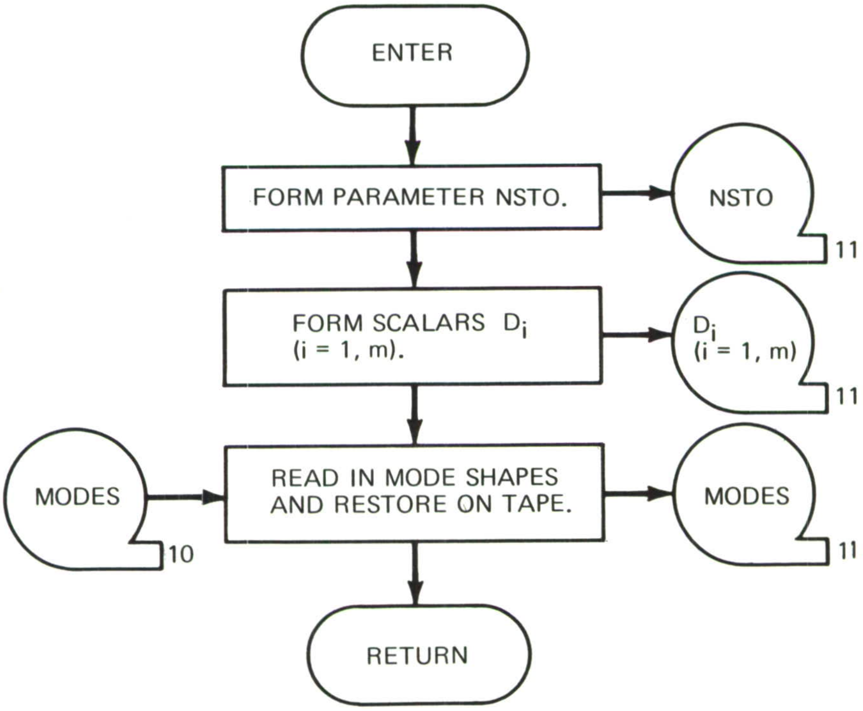

ENTER
FORM PARAMETER NSTO.
NSTO
11
FORM SCALARS D_i (i = 1, m).
D_i (i = 1, m)
11
MODES
10
READ IN MODE SHAPES AND RESTORE ON TAPE.
MODES
11
RETURN

Figure 58. SECM3 Flow Chart

(i) Subroutine SECM2

The second-spectral-moment scalars for option 2 deflection covariance are calculated in subroutine SECM2 in the same manner as in subroutine ADMIN2, section IV 2. c. (2)(c).

(j) Subroutine ADMIT2

This subroutine (figure 59) calculates the admittance scalars used in the formation of cross PSD. The cross-modal constants and mode shapes are stored on tape.

Method: The admittance scalars are combined in the following manner:

$$
\begin{aligned}
DDEE_{ij} &= D_i D_j + E_i E_j \\
DE_{ij} &= D_i E_j - D_j E_i \\
ED_{ij} &= D_j E_i - D_i E_j
\end{aligned}
$$

where: $i = 1, m - 1$

$j = i + 1, i + K$

See the Engineering User's Guide, reference 3, for a definition of D_i and E_i .

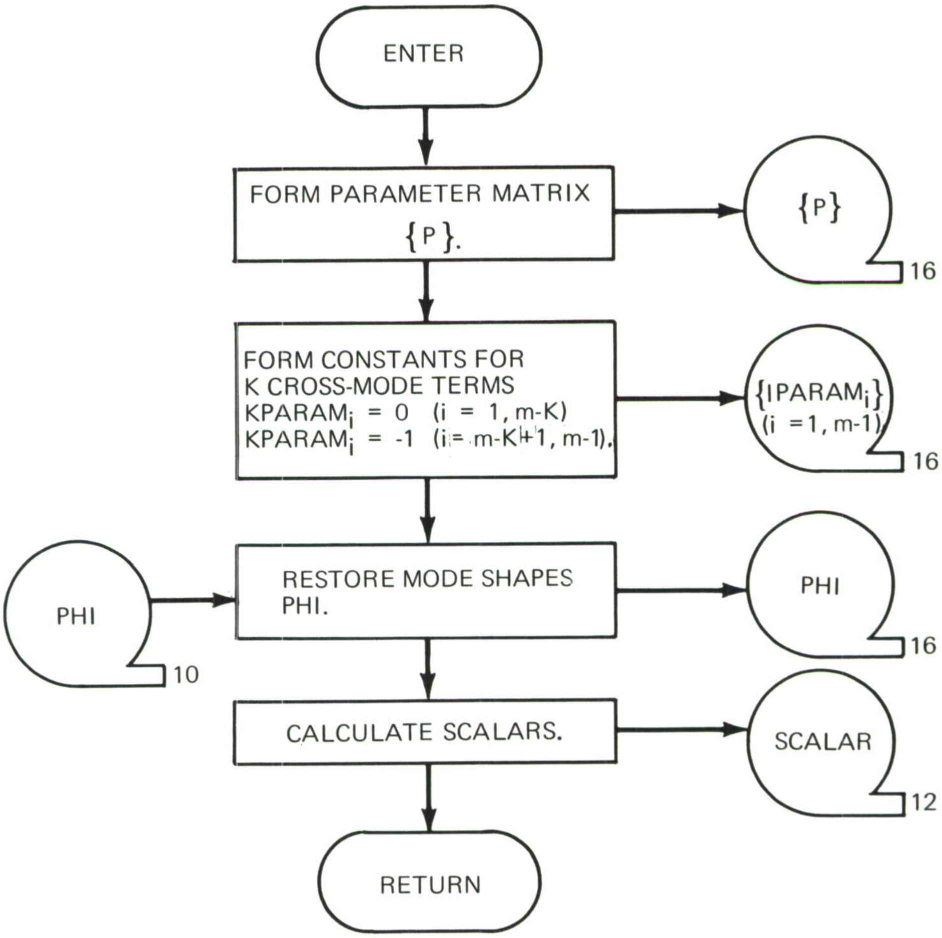
Input: Modes shapes from phase I output tape

Output: Admittance scalars on tape

Error: Standard READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Length: 14566_8



ENTER
FORM PARAMETER MATRIX {P}.
{P}
16
FORM CONSTANTS FOR K CROSS-MODE TERMS
KPARAM$_i$ = 0 (i = 1, m-K)
KPARAM$_i$ = -1 (i = m-K+1, m-1).
{IPARAM$_i$} (i =1, m-1)
16
PHI
10
RESTORE MODE SHAPES PHI.
PHI
16
CALCULATE SCALARS.
SCALAR
12
RETURN

Figure 59. ADMIT2 Flow Chart

(k) Subroutine CQCPSD

This subroutine (figure 60) combines the excitation matrices and the admittance scalars for the real part and imaginary part in generating the cross-PSD matrices.

Method: For the real part,

$$[CQ]_{ij} = \alpha_{ij} \left[C_F\right]_{ij} + \gamma_{ij} \left[Q_F\right]_{ij}$$

For the imaginary part,

$$[CQ']_{ij} = - \gamma_{ij} \left[C_F\right]_{ij} + \alpha_{ij} \left[Q_F\right]_{ij}$$

where: $\alpha_{ij} = D_i D_j + E_i E_j$

$\gamma_{ij} = D_i E_j - D_j E_i$

$i = 1, m - 1$

$j = i + 1, i + K$

Input: Admittance scalars and the excitation co- and quad-PSD matrices from tapes

Output: The resultant matrices are stored on tape.

Error: Standard READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Length: 15155_8

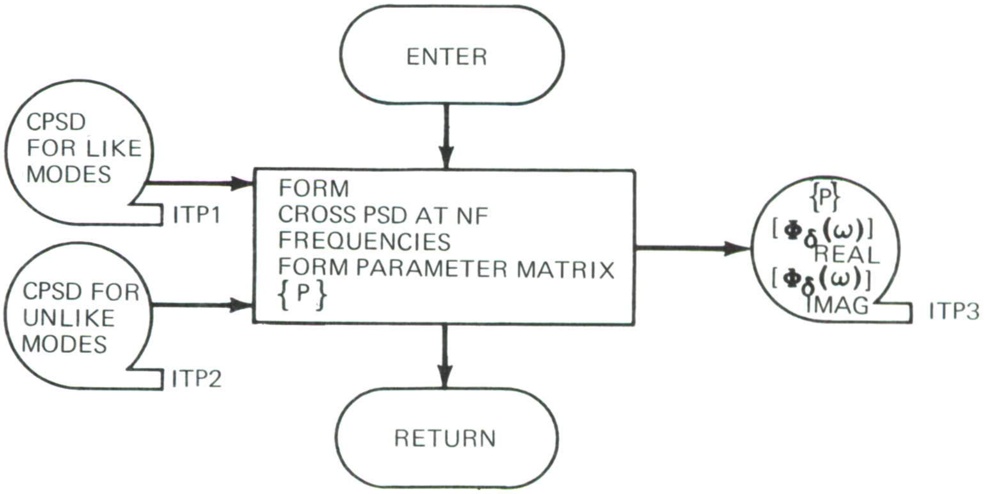

ENTER
CPSD FOR LIKE MODES
ITP1
CPSD FOR UNLIKE MODES
ITP2
FORM CROSS PSD AT NF FREQUENCIES FORM PARAMETER MATRIX {P}
{P}
[Φδ(ω)] REAL
[Φδ(ω)] IMAG
ITP3
RETURN

Figure 60. CQCPSD Flow Chart

(l) Subroutine SUM3

Method: This subroutine (figure 61) sums to obtain the deflection co-PSD matrices from like and unlike modal contributions.

The deflection quad-PSD matrices are transferred from an input tape to an output tape.

Input: Cross-PSD matrices for like and unlike modes are stored on ITP1 and ITP2

Output: Deflection cross-PSD matrices for NF frequencies are stored on ITP3

Error: READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Argument list: ITP1—Option 3 deflection cross-PSD matrices (like modal contributions) are stored on this tape.

ITP2—Cross-PSD matrices (contributions from unlike modes only) are stored on this tape.

ITP3—Output tape of summation of all deflection cross-PSD matrices for NF frequencies.

Length: 40343_8

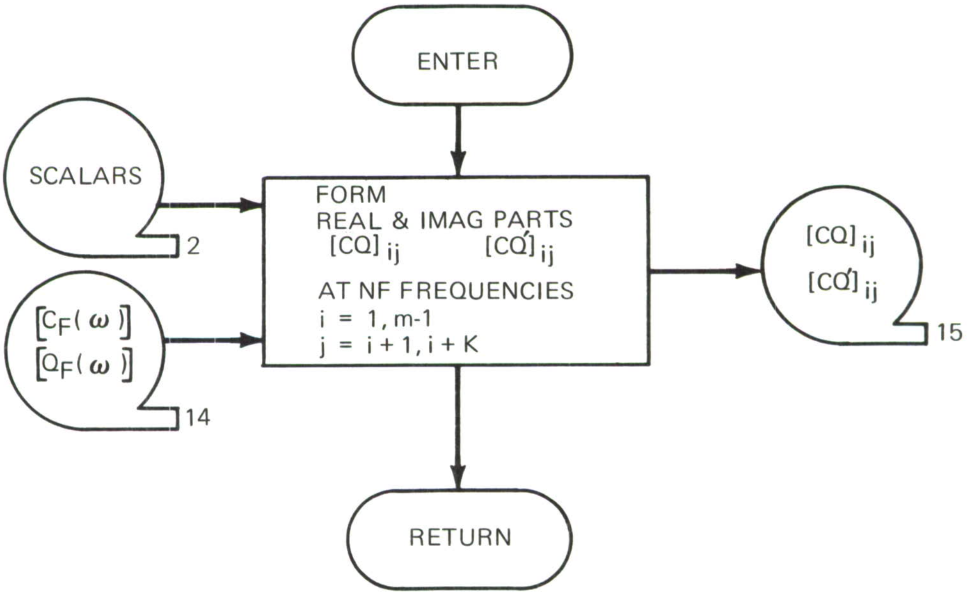

ENTER
SCALARS
2
$[C_F(\omega)]$
$[Q_F(\omega)]$
14
FORM
REAL & IMAG PARTS
$[CQ]_{ij}$ $[CQ']_{ij}$
AT NF FREQUENCIES
i = 1, m-1
j = i + 1, i + K
$[CQ]_{ij}$
$[CQ']_{ij}$
15
RETURN

Figure 61. SUM3 Flow Chart

(m) TL01 Subroutine DJNT2

This subroutine (figure 62) calculates the deflection covariance matrices.

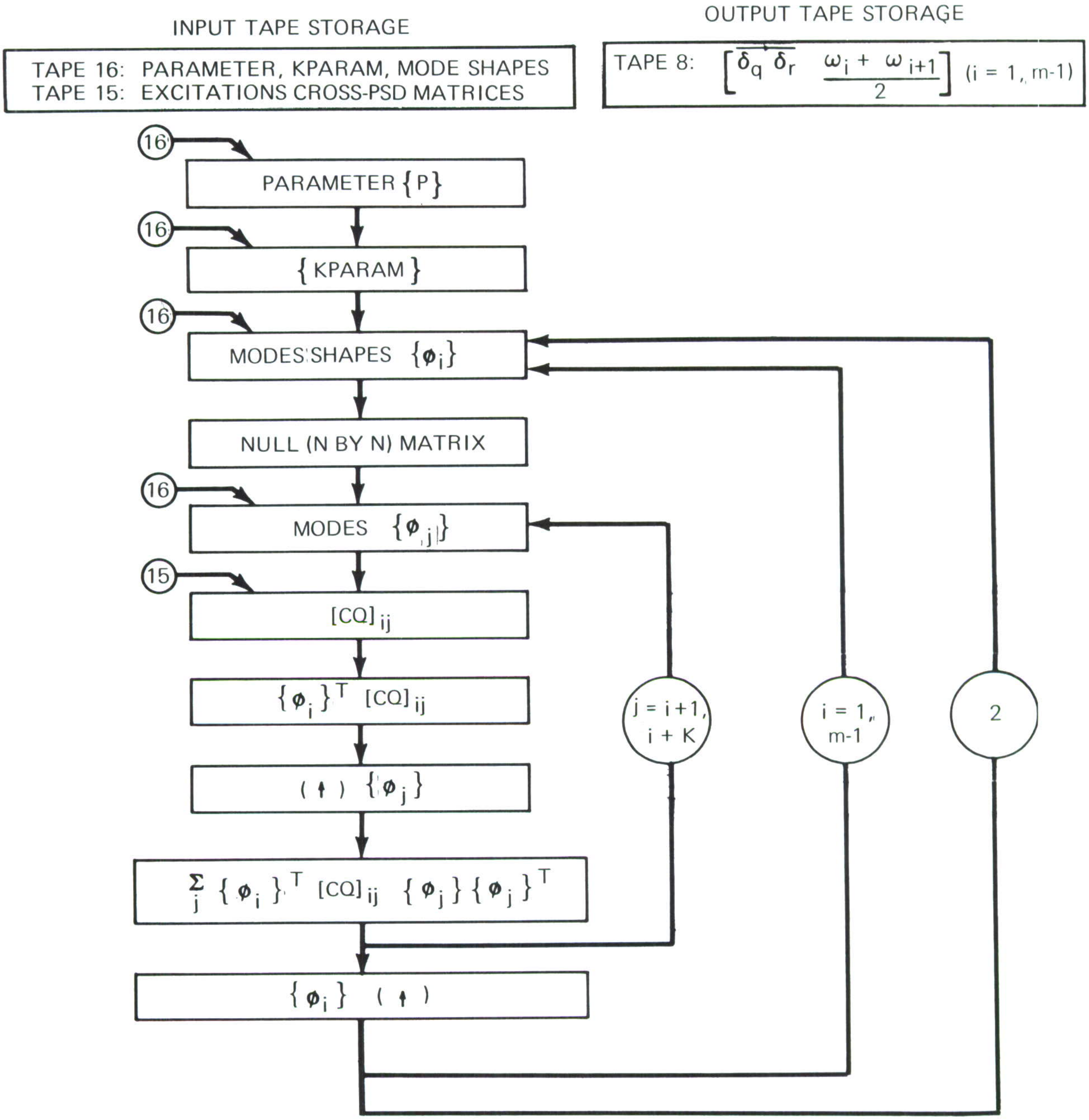

INPUT TAPE STORAGE
TAPE 16: PARAMETER, KPARAM, MODE SHAPES
TAPE 15: EXCITATIONS CROSS-PSD MATRICES
OUTPUT TAPE STORAGE
TAPE 8: $\left[\overline{\delta_q \delta_r} \quad \frac{\omega_i + \omega_{i+1}}{2}\right]$ (i = 1, m-1)
16
PARAMETER {P}
16
{KPARAM}
16
MODES SHAPES $\{\phi_i\}$
NULL (N BY N) MATRIX
16
MODES $\{\phi_j\}$
15
$[CQ]_{ij}$
$\{\phi_i\}^T [CQ]_{ij}$
(↑) $\{\phi_j\}$
$\sum_j \{\phi_i\}^T [CQ]_{ij} \{\phi_j\}\{\phi_j\}^T$
$\{\phi_i\}$ (↑)
j = i+1, i + K
i = 1, m-1
2

Figure 62. DJNT2 Flow Chart

(n) TL01 Subroutine SJNT2

This subroutine (figure 63) calculates the joint stress $[\overline{\sigma_s \sigma_t}]$.

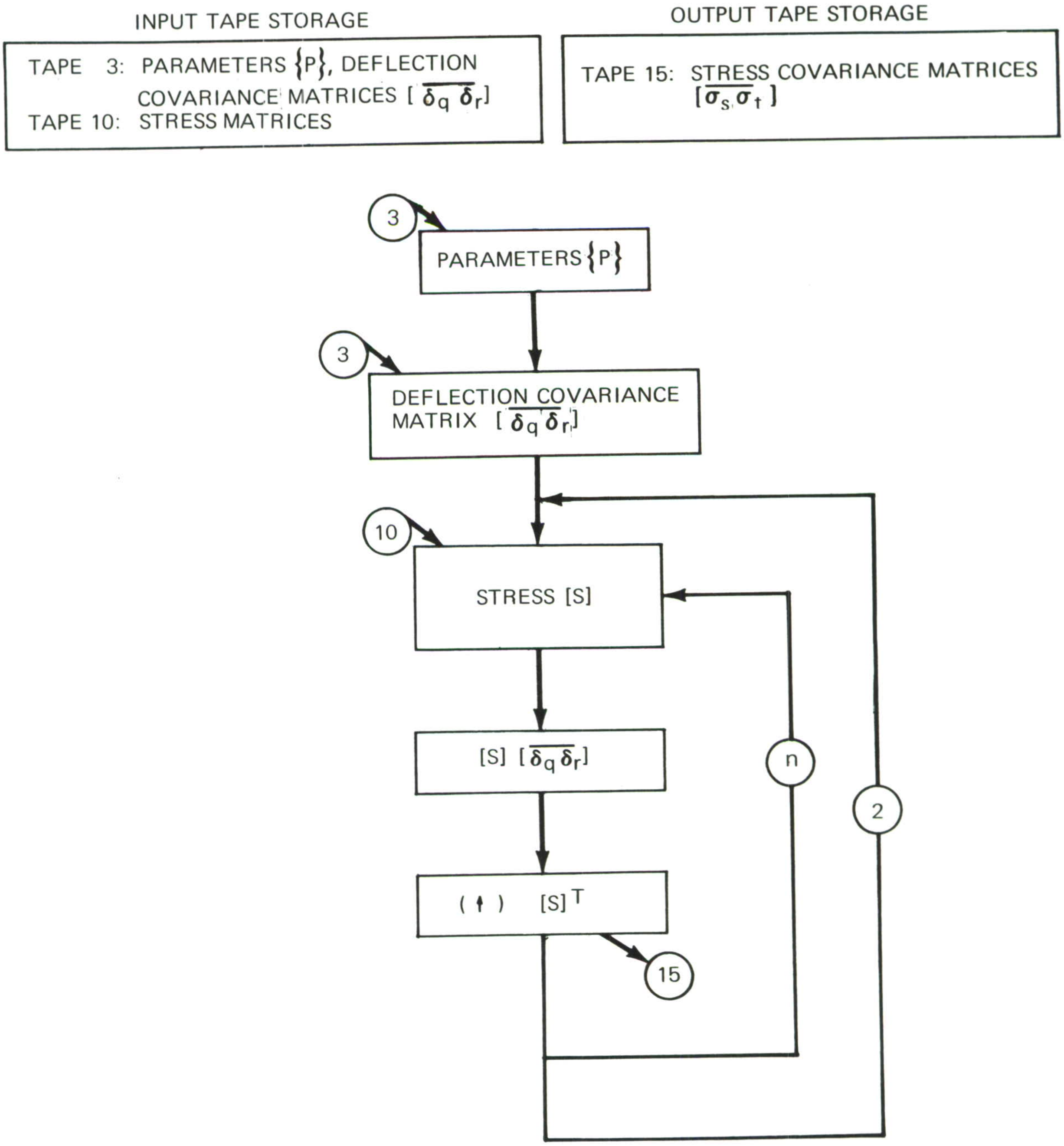

INPUT TAPE STORAGE
TAPE 3: PARAMETERS $\{P\}$, DEFLECTION COVARIANCE MATRICES $[\overline{\delta_q \delta_r}]$
TAPE 10: STRESS MATRICES
OUTPUT TAPE STORAGE
TAPE 15: STRESS COVARIANCE MATRICES $[\overline{\sigma_s \sigma_t}]$
3
PARAMETERS $\{P\}$
3
DEFLECTION COVARIANCE MATRIX $[\overline{\delta_q \delta_r}]$
10
STRESS [S]
$[S]\ [\overline{\delta_q \delta_r}]$
$(\uparrow)\ [S]^T$
15
n
2

Figure 63. SJNT2 Flow Chart

(o) TL01 Subroutine DSECM2

This subroutine (figure 64) calculates the deflection second spectral moments.

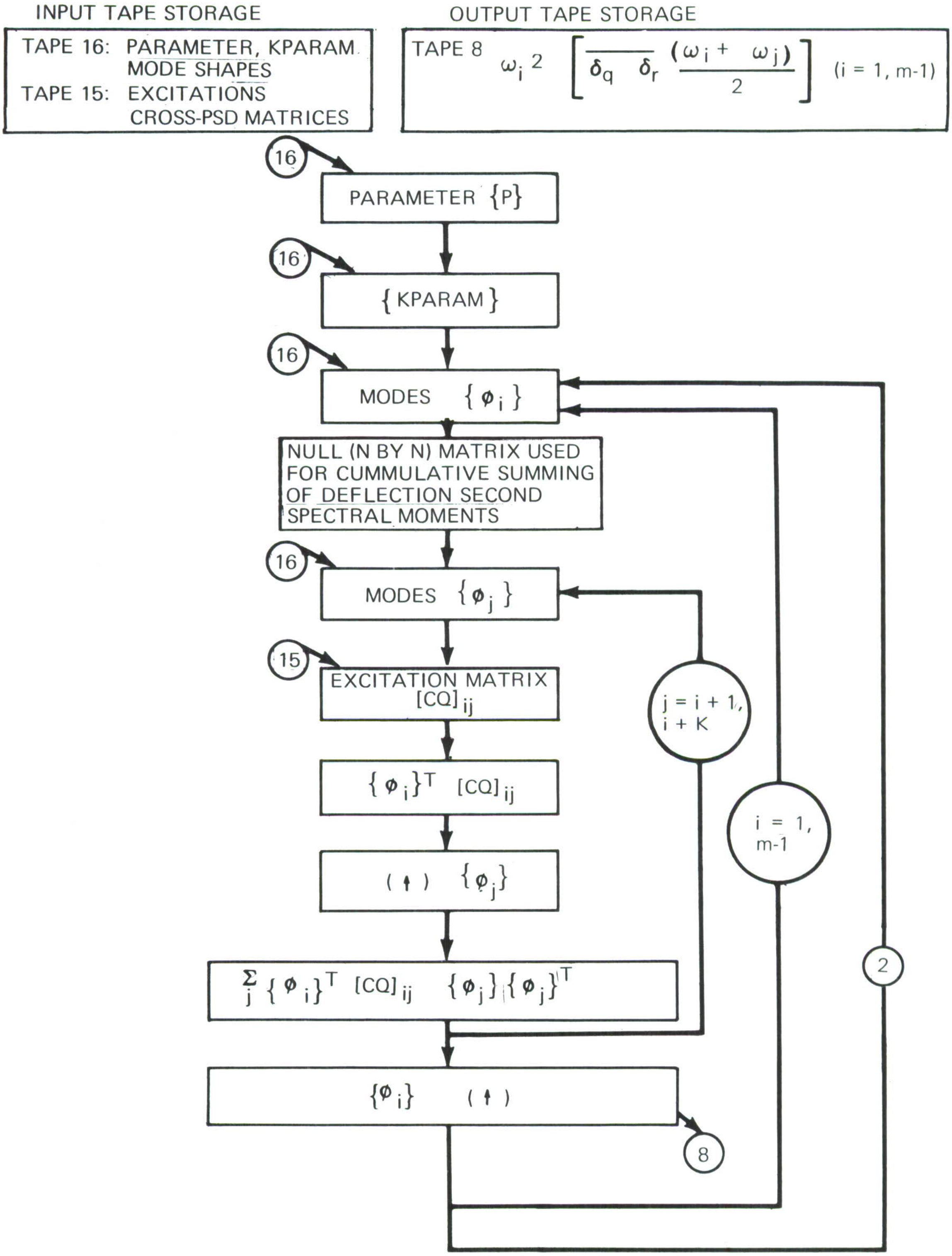

INPUT TAPE STORAGE
TAPE 16: PARAMETER, KPARAM
MODE SHAPES
TAPE 15: EXCITATIONS
CROSS-PSD MATRICES
OUTPUT TAPE STORAGE
TAPE 8 $\omega_i{}^2 \left[\overline{\delta_q \quad \delta_r} \; \frac{(\omega_i + \omega_j)}{2} \right]$ (i = 1, m-1)
16
PARAMETER $\{P\}$
16
$\{$ KPARAM $\}$
16
MODES $\{\phi_i\}$
NULL (N BY N) MATRIX USED FOR CUMMULATIVE SUMMING OF DEFLECTION SECOND SPECTRAL MOMENTS
16
MODES $\{\phi_j\}$
15
EXCITATION MATRIX $[CQ]_{ij}$
$\{\phi_i\}^T \; [CQ]_{ij}$
$(\uparrow) \; \{\phi_j\}$
$\sum_j \{\phi_i\}^T \; [CQ]_{ij} \; \{\phi_j\}\{\phi_j\}^T$
$\{\phi_i\} \; (\uparrow)$
8
j = i + 1, i + K
i = 1, m-1
2

Figure 64. DSECM2 Flow Chart

(p) TL01 Subroutine SSECM2

This subroutine (figure 65) calculates the joint stress second spectral moments.

INPUT TAPE STORAGE

TAPE 3: PARAMETER, DEFLECTION SECOND SPECTRAL MOMENT MATRIX
TAPE 10: STRESS MATRICES

OUTPUT TAPE STORAGE

TAPE 15: STRESS SECOND-SPECTRAL-MOMENT MATRIX

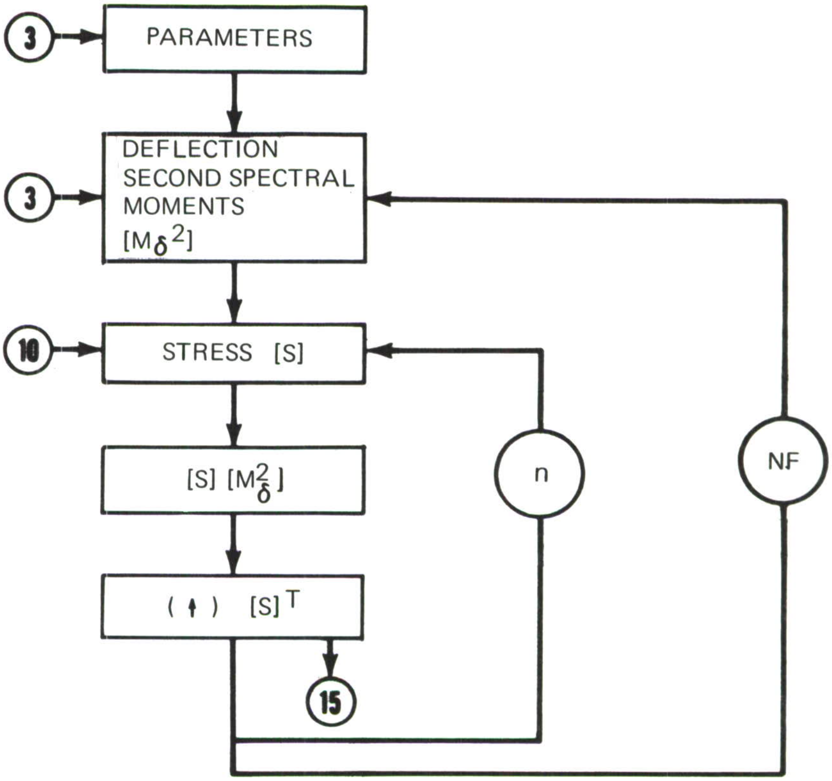

3
PARAMETERS
3
DEFLECTION SECOND SPECTRAL MOMENTS $[M_\delta{}^2]$
10
STRESS [S]
$[S]\,[M_\delta^2]$
(↑) $[S]^T$
15
n
NF

Figure 65. SSECM2 Flow Chart

(q) TL01 Subroutine CPSD2

This subroutine (figure 66) calculates the cross modal contributions to the deflection cross-PSD matrices at NF frequencies

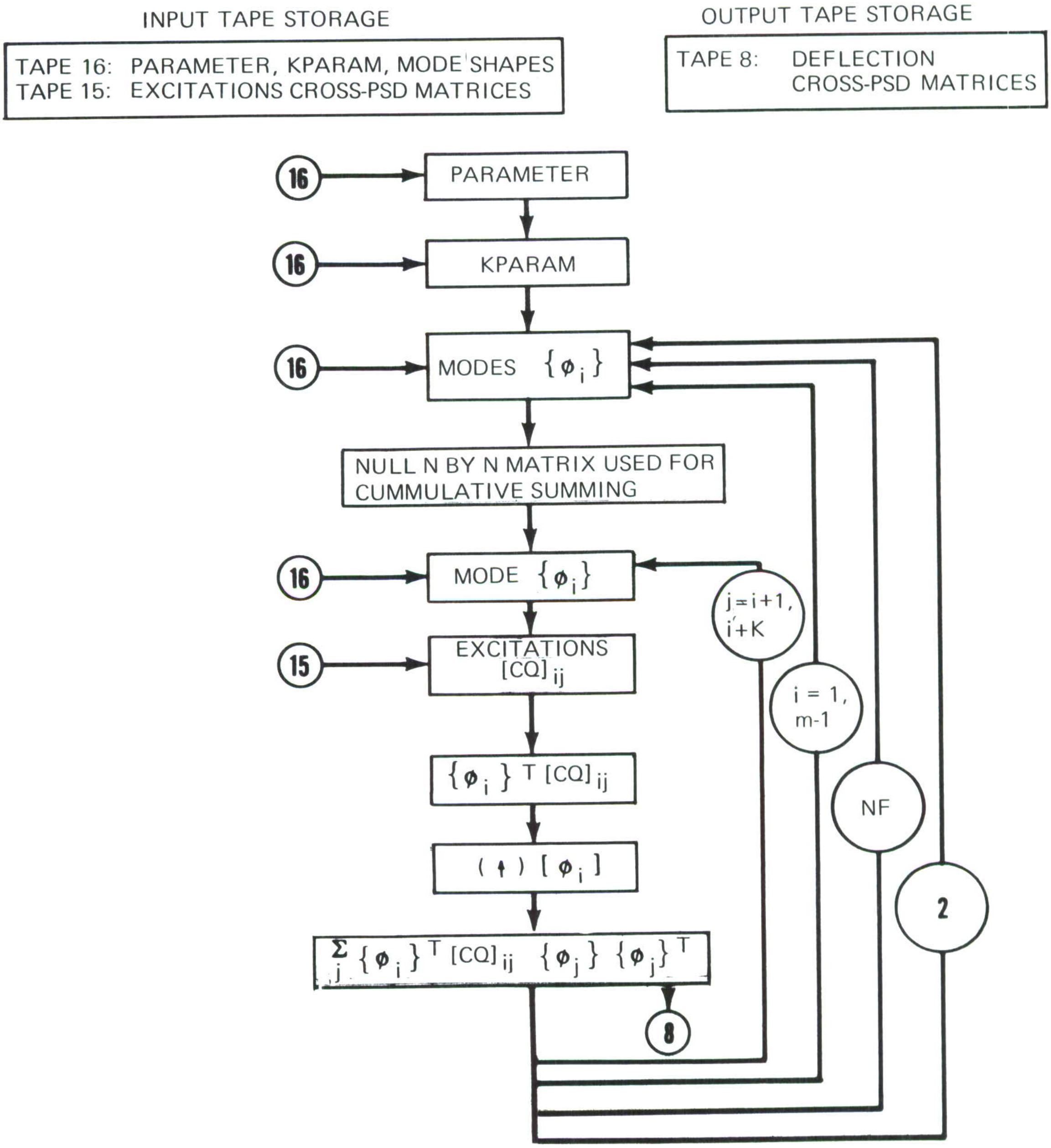

INPUT TAPE STORAGE
TAPE 16: PARAMETER, KPARAM, MODE SHAPES
TAPE 15: EXCITATIONS CROSS-PSD MATRICES
OUTPUT TAPE STORAGE
TAPE 8: DEFLECTION CROSS-PSD MATRICES
16
PARAMETER
16
KPARAM
16
MODES {φ_i}
NULL N BY N MATRIX USED FOR CUMMULATIVE SUMMING
16
MODE {φ_j}
15
EXCITATIONS [CQ]_ij
{φ_i}^T [CQ]_ij
(↑) [φ_j]
Σ_j {φ_i}^T [CQ]_ij {φ_j} {φ_j}^T
8
j=i+1, i+K
i = 1, m-1
NF
2

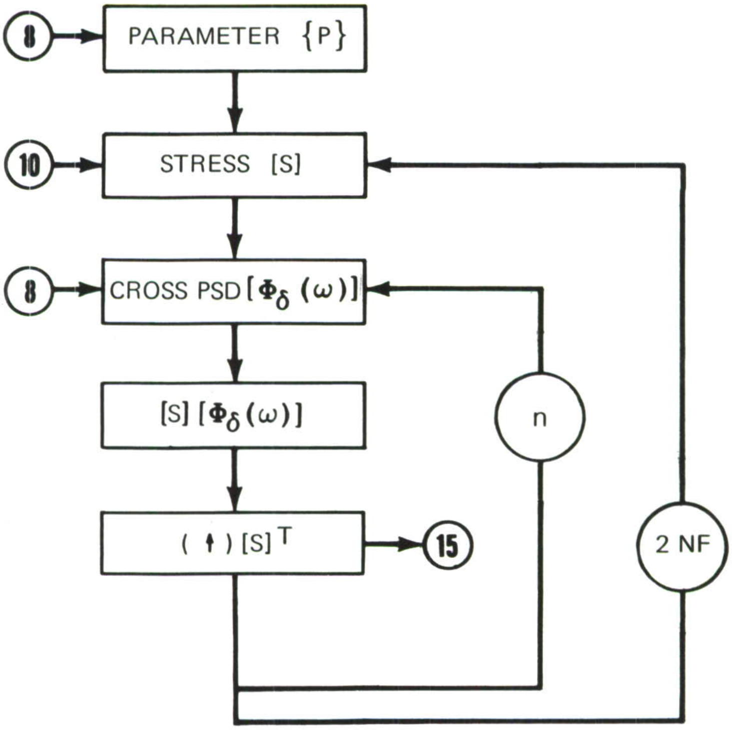
Figure 66. CPSD2 Flow Chart

(r) TL01 Subroutine SRESP2

This subroutine (figure 67) calculates the stress cross-PSD matrices for NF frequencies.

INPUT TAPE STORAGE	
TAPE 8:	PARAMETERS DEFLECTION CROSS-PSD MATRICES
TAPE 10:	STRESSES

OUTPUT TAPE STORAGE	
TAPE 15:	STRESS CROSS-PSD MATRICES



8
PARAMETER {P}
10
STRESS [S]
8
CROSS PSD $[\Phi_\delta(\omega)]$
$[S][\Phi_\delta(\omega)]$
$(\uparrow)[S]^T$
15
n
2 NF

Figure 67. SRESP2 Flow Chart

d. Option 3 Solution Program—Normal Modes without Cross Terms

(1) Organization

Option 3 is in two segments: (1) deflection covariance and (2) deflection cross PSD. In this option, all modal cross-product terms are omitted. The solutions for the imaginary parts are null. The limitations are as follows:

$$N \le 90$$
$$m \le 25$$
$$NF \le 90$$

(a) Segment 1—Deflection Covariance

Step 1: The excitation co-PSD matrices are calculated in subroutine RANLOD. See section IV 1.

Step 2: The admittance integral scalars are calculated in subroutine ADMIN3. See section IV 2. d. (2)(b).

Step 3: The deflection covariance matrix is calculated in TL01 subroutine DJNT3. See section IV 2. d. (2)(f). There are m (number of normal modes) deflection covariance matrices stored on a scratch tape. Subroutine ADDMAT, section IV 2. d. (2)(c), sums the deflection covariance matrices over m normal modes.

Step 4: The stress covariance matrices are calculated in TL01 subroutine SJNT3, section IV 2. d. (2)(g), using the stress matrices from the phase I output tape and the deflection covariance calculated in step 3. The deflection covariance is premultiplied by the stress matrices and postmultiplied by the transpose of these matrices.

Step 5: The deflection second-spectral-moment matrices are calculated in subroutine DSECM3. See section IV 2. d. (2)(d). The deflection covariance matrices calculated in step 3 are multiplied by ω_i^2 and summed over m normal modes.

Step 6: The stress second spectral moments are calculated in TL01 subroutine DSJNT3. See section IV 2. d. (2)(h). The deflection second-spectral-moment matrices calculated in step 5 are premultiplied by $[S]$ and postmultiplied by $[S]^T$.

(b) Segment 2—Cross-PSD Solution

Step 1: The excitation cross PSD's are calculated in subroutine RANLOD, section IV 1, for each frequency. The NF frequencies are card inputs.

Step 2: The admittance scalars are calculated in subroutine ADMIT3, section IV 2. d. (2)(e), for each frequency.

Step 3: The deflection cross-PSD solutions are calculated in TL01 subroutine CPSD3. See section IV 2. d. (2)(i).

Step 4: The deflection cross-PSD matrices calculated in step 3 are summed in subroutine ADDMAT, section IV 2. d. (2)(c), over m normal modes for each of the NF frequencies.

Step 5: The stress cross-PSD matrices are calculated in TL01 subroutine SRESP3. (See section IV 2. d. (2)(j).) The deflection cross-PSD matrices calculated in step 4 are premultiplied by the stress matrices and postmultiplied by the transpose of these matrices for each of the NF frequencies.

(2) Subroutine Descriptions

(a) Subroutine RANLOD (section IV 1.)

(b) Subroutine ADMIN3 (figure 68)

The admittance integral scalars D_i are calculated and stored on tape. The mode shapes are read from the phase I output tape and re-stored on tape.

Method:

$$D_i = \pi/\left(2\,\mu_i\,\omega_i^{2}\,M_i^{2}\right)$$

where

$$\mu_i = \mu + \lambda\,\omega_i^{2} + g\,\omega_i \quad (i = 1,\ m)$$

Input: All inputs come from labeled common.

Output: The scalars and mode shapes are stored on tape.

Error: READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Argument list: None

Length: 5540_8

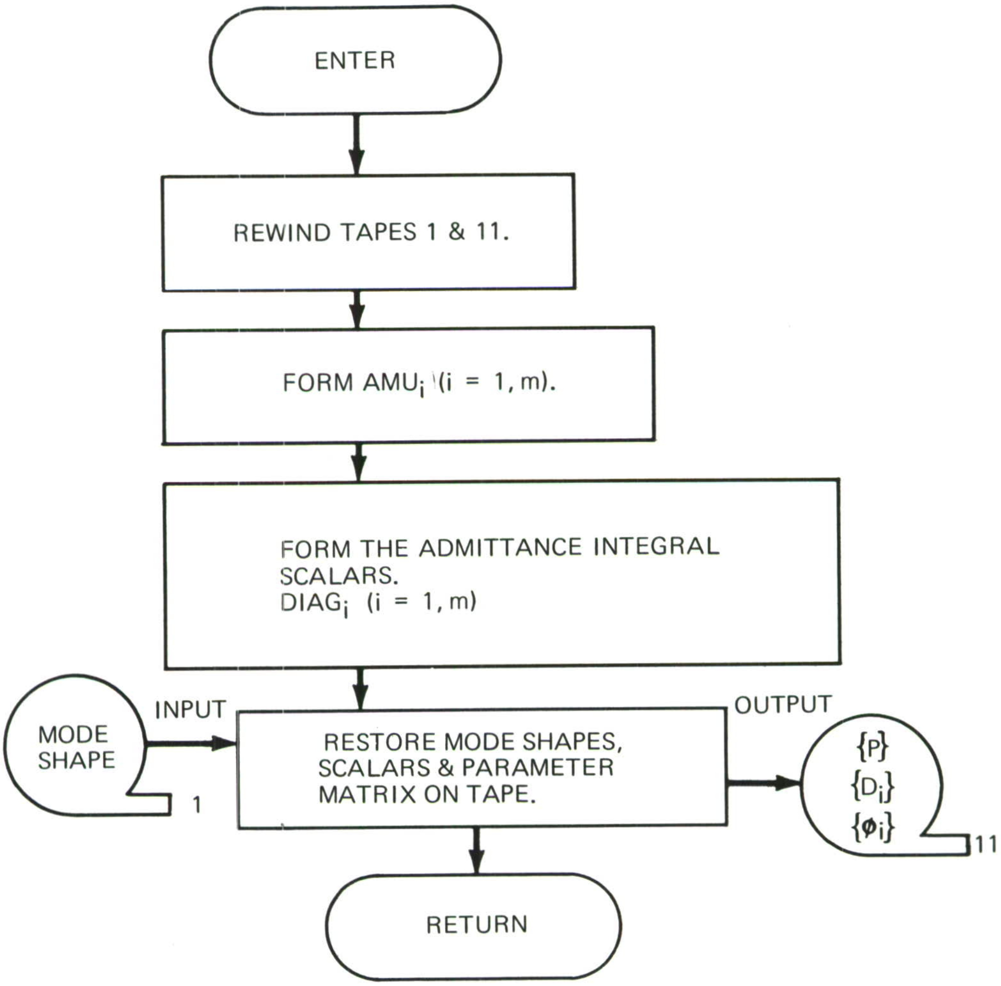

ENTER
REWIND TAPES 1 & 11.
FORM AMU$_i$ (i = 1, m).
FORM THE ADMITTANCE INTEGRAL SCALARS.
DIAG$_i$ (i = 1, m)
MODE SHAPE
INPUT
1
RESTORE MODE SHAPES, SCALARS & PARAMETER MATRIX ON TAPE.
OUTPUT
$\{P\}$
$\{D_i\}$
$\{\phi_i\}$
11
RETURN

Figure 68. ADMIN3 Flow Chart

(c) Subroutine ADDMAT

This subroutine (figure 69) adds deflection covariance or cross-PSD matrices that are stored on tape.

Method: The matrices that are to be summed come from a tape (INTAPE). Each matrix is read into the core, summed, and stored on tape (OUTAPE).

Input: Matrices are input from INTAPE.

Output: The resultant matrix is stored on OUTAPE.

Error: Standard READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Argument list:

INTAPE—Number of the tape that contains the matrices to be summed

OUTAPE —Number of the tape that contains the summation of the matrices from INTAPE

NO—For the cross-PSD calculation, this variable equals NF . For deflection covariance calculations, this variable equals 1.

Length: 40330_8

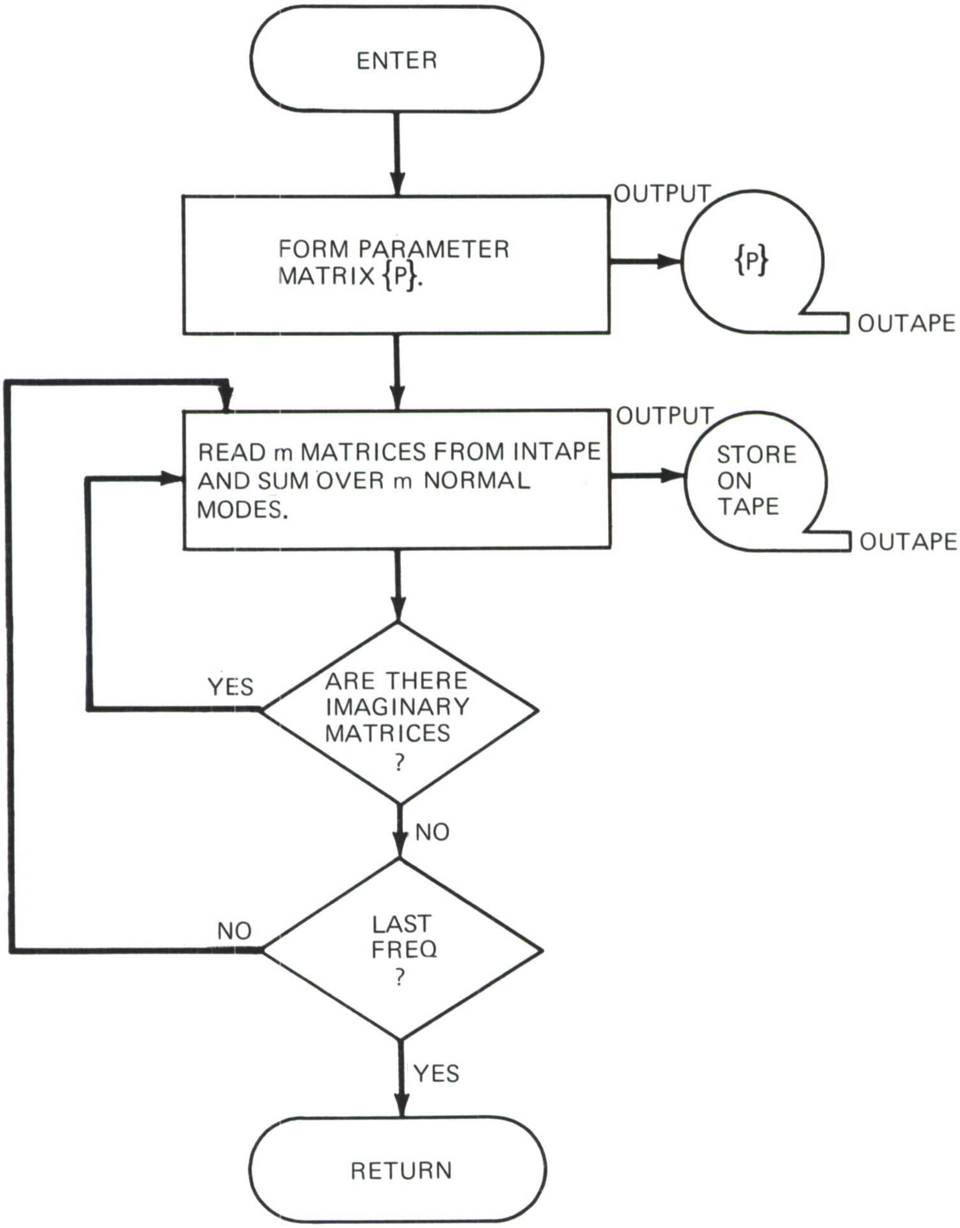

ENTER
FORM PARAMETER MATRIX {P}.
OUTPUT
{P}
OUTAPE
READ m MATRICES FROM INTAPE AND SUM OVER m NORMAL MODES.
OUTPUT
STORE ON TAPE
OUTAPE
ARE THERE IMAGINARY MATRICES ?
YES
NO
LAST FREQ ?
NO
YES
RETURN

Figure 69. ADDMAT Flow Chart

(d) Subroutine DSECM3 (figure 70)

Method: The deflection covariance matrices that are calculated in subroutine DJNT3 are multiplied by the square of the frequency for each mode and summed to form the deflection second spectral moments.

$$\left[M_{\delta}^{2}\right] = \sum_{i=1}^{m} \left[\overline{\delta_q \delta_r}\right]_i \omega_i^{2}$$

Input: Deflection covariance matrices are from tape.

Output: Deflection second-spectral-moment matrix and a parameter matrix

Error: Standard READTP/WRTETP error messages

Subroutine required: READTP/WRTETP

Argument list: None

Length: 40175_8

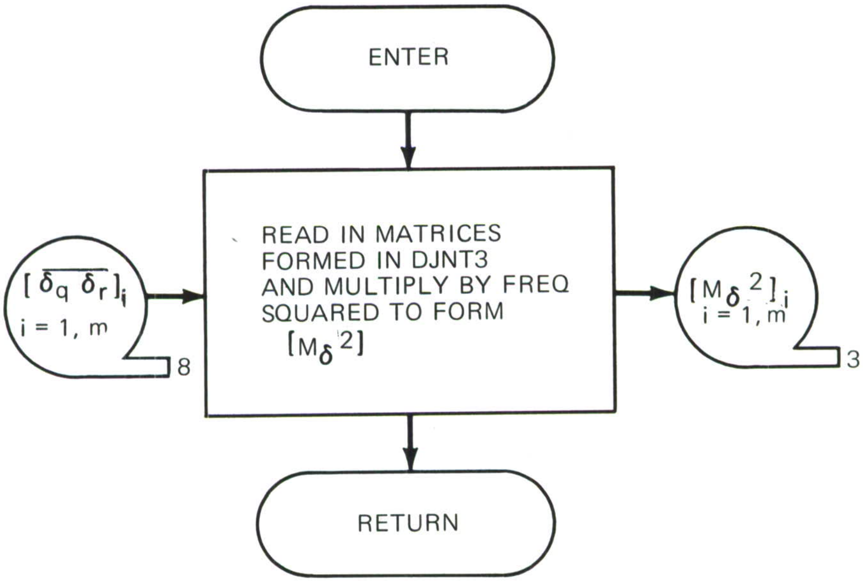

ENTER
READ IN MATRICES FORMED IN DJNT3 AND MULTIPLY BY FREQ SQUARED TO FORM $[M_\delta 2]$
$[\overline{\delta_q \delta_r}]_i$
i = 1, m
8
$[M_\delta 2]_i$
i = 1, m
3
RETURN

Figure 70. DSECM3 Flow Chart

(e) Subroutine ADMIT3 (figure 71)

Method: This subroutine reads the mode shapes from the phase I output tape and re-stores them on another tape. The admittance scalars are calculated and stored on tape.

$$D_i = \frac{\omega_i^2 - \omega^2}{M_i \left[\left(\omega_i^2 - \omega^2 \right)^2 + \omega^2 \, (\mu_i)^2 \right]}$$

$$E_i = \frac{\omega \, \mu_i}{M_i \left[\left(\omega_i^2 - \omega^2 \right)^2 + \omega^2 \, (\mu_i)^2 \right]}$$

where

$$\mu_i = \mu + \lambda \, \omega_i^2 + \frac{g \, \omega_i^2}{\omega}$$

The admittance scalars are then squared and summed to form $D_i^2 + E_i^2$ $(i = 1, m)$.

Input: From phase I output tape

Output: Mode shapes and the admittance scalars for each mode are stored on tape.

Error: Standard READTP/WRTETP error messages

Subroutines required: READTP/WRTETP

Argument list: None

Length: 6013_8

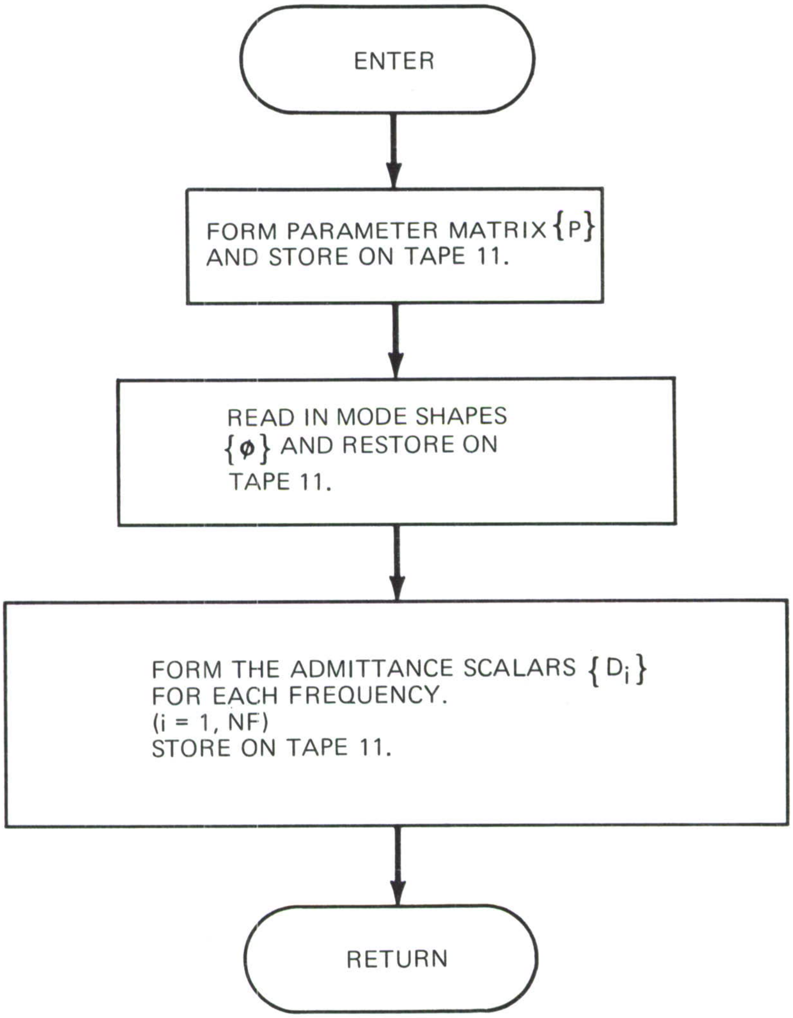

ENTER
FORM PARAMETER MATRIX {P} AND STORE ON TAPE 11.
READ IN MODE SHAPES {φ} AND RESTORE ON TAPE 11.
FORM THE ADMITTANCE SCALARS {D_i} FOR EACH FREQUENCY. (i = 1, NF) STORE ON TAPE 11.
RETURN

Figure 71. ADMIT3 Flow Chart

(f) TL01 Subroutine DJNT3 (figure 72)

The deflection covariance matrices are calculated.

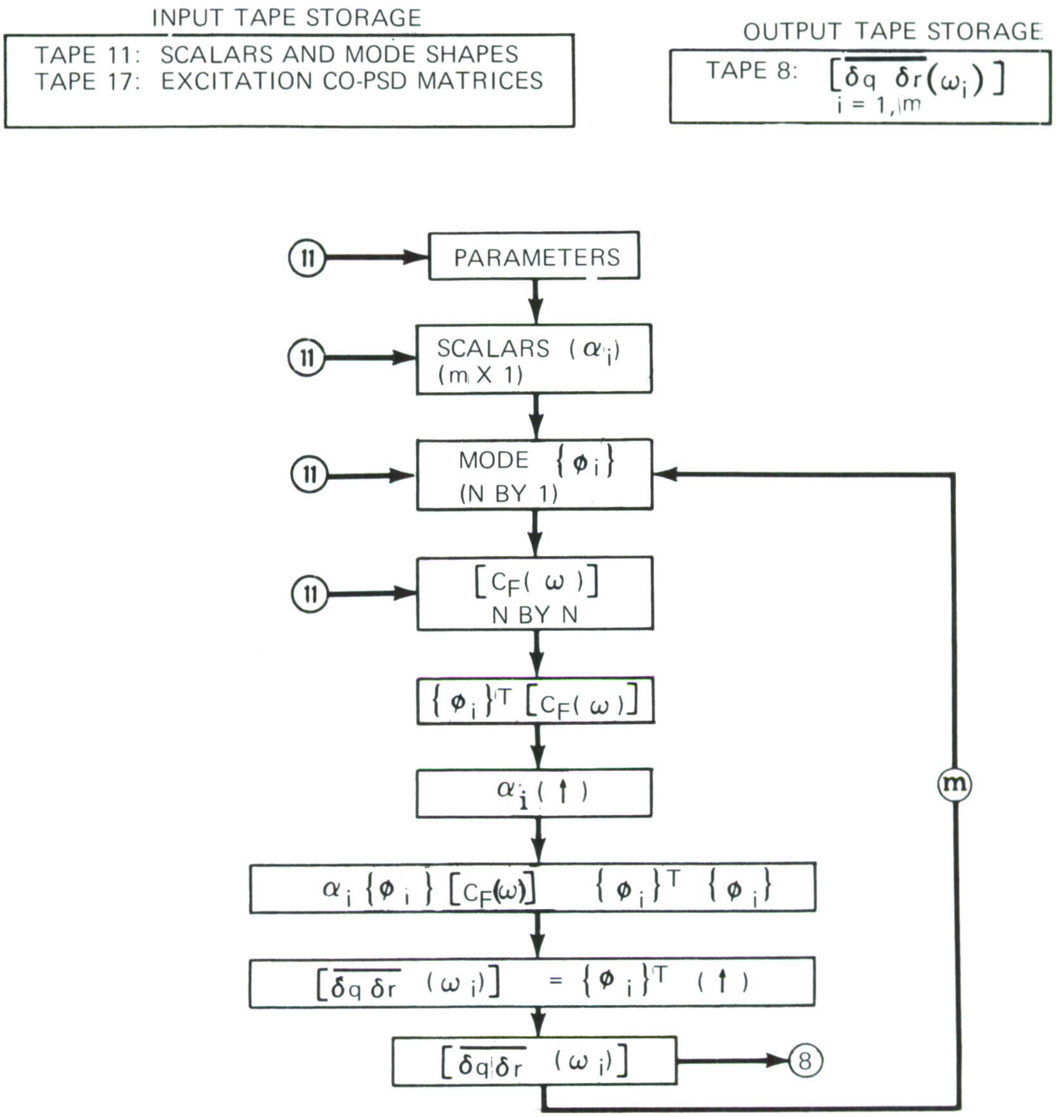

INPUT TAPE STORAGE
TAPE 11: SCALARS AND MODE SHAPES
TAPE 17: EXCITATION CO-PSD MATRICES
OUTPUT TAPE STORAGE
TAPE 8: $\left[\overline{\delta q\ \delta r}(\omega_i)\right]$ $i = 1, m$
11
PARAMETERS
11
SCALARS (α_i) (m X 1)
11
MODE $\{\phi_i\}$ (N BY 1)
11
$[C_F(\omega)]$ N BY N
$\{\phi_i\}^T [C_F(\omega)]$
$\alpha_i (\dagger)$
$\alpha_i \{\phi_i\} [C_F(\omega)] \quad \{\phi_i\}^T \{\phi_i\}$
$[\overline{\delta q\, \delta r}(\omega_i)] = \{\phi_i\}^T (\dagger)$
$[\overline{\delta q\, \delta r}(\omega_i)]$
8
m

Figure 72. DJNT3 Flow Chart

(g) TL01 Subroutine SJNT3 (figure 73)

This subroutine calculates the stress covariance matrix.

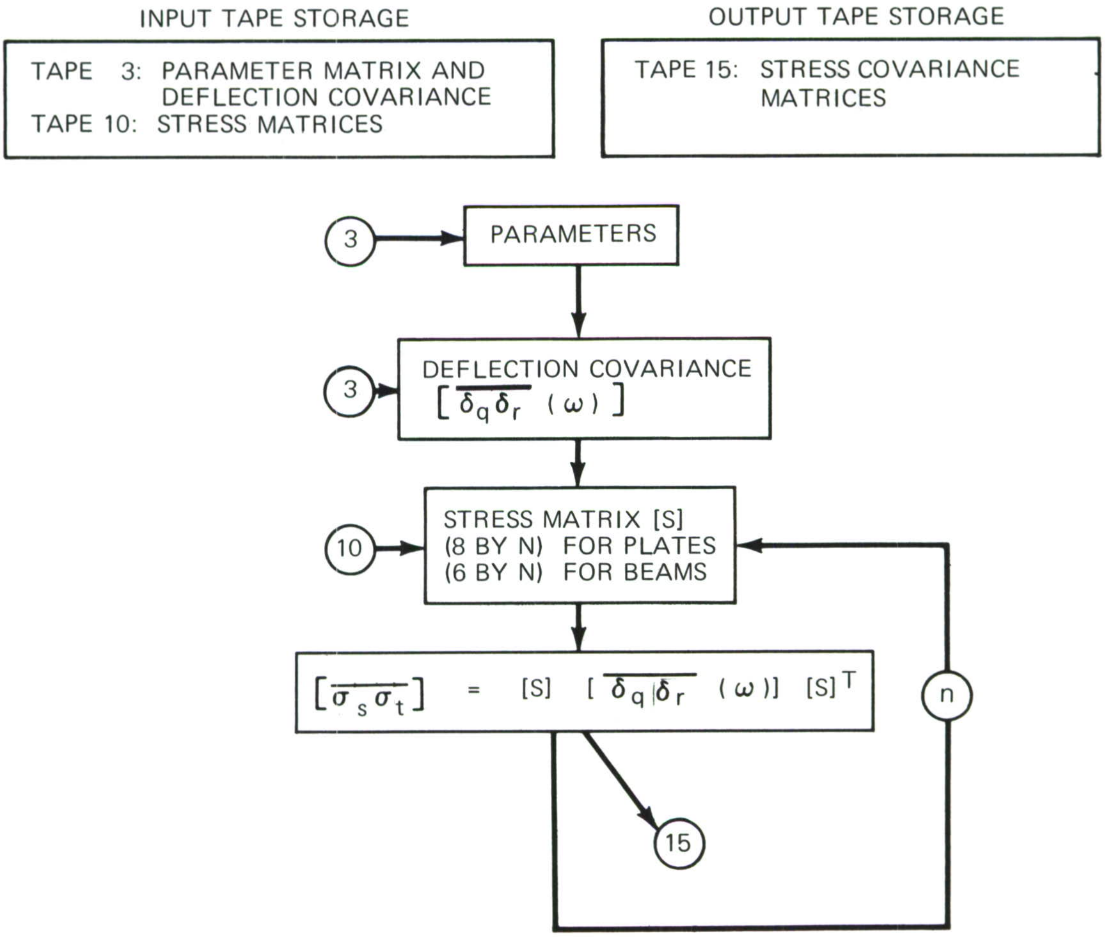

INPUT TAPE STORAGE
TAPE 3: PARAMETER MATRIX AND DEFLECTION COVARIANCE
TAPE 10: STRESS MATRICES
OUTPUT TAPE STORAGE
TAPE 15: STRESS COVARIANCE MATRICES
3
PARAMETERS
3
DEFLECTION COVARIANCE
$[\overline{\delta_q \delta_r}\ (\omega)]$
10
STRESS MATRIX [S]
(8 BY N) FOR PLATES
(6 BY N) FOR BEAMS
$[\overline{\sigma_s \sigma_t}] = [S]\ [\overline{\delta_q \delta_r}\ (\omega)]\ [S]^T$
n
15

Figure 73. SJNT3 Flow Chart

(h) TL01 Subroutine DSJNT3 (figure 74)

This subroutine calculates the stress second-spectral-moment matrix.

INPUT TAPE STORAGE

TAPE 3: PARAMETER MATRIX AND DEFLECTION SECOND-SPECTRAL-MOMENT MATRICES
TAPE 10: STRESS MATRICES

OUTPUT TAPE STORAGE

TAPE 15: STRESS SECOND SPECTRAL MOMENT MATRICES

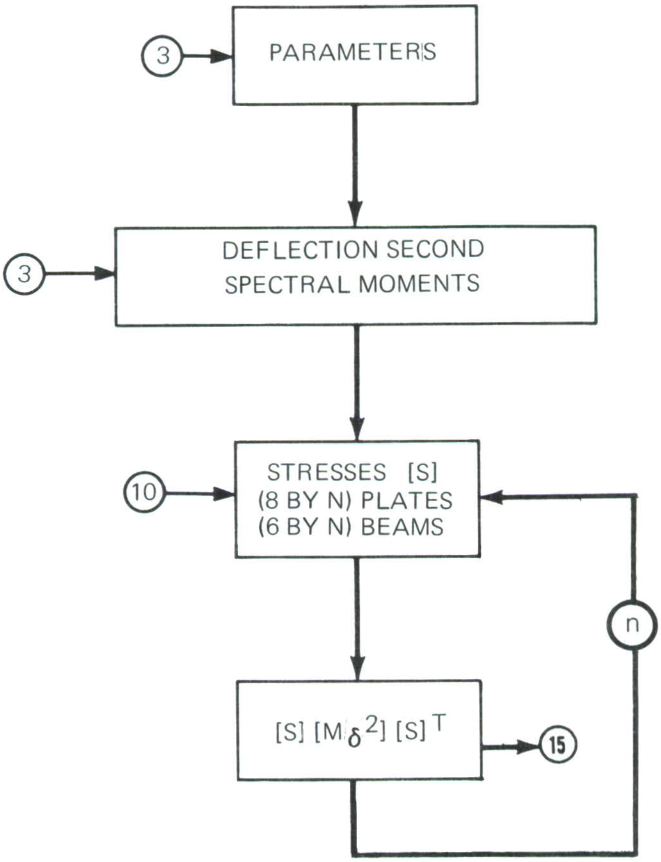

3
PARAMETERS
3
DEFLECTION SECOND SPECTRAL MOMENTS
10
STRESSES [S]
(8 BY N) PLATES
(6 BY N) BEAMS
n
$[S]\,[M_{\delta}{}^{2}]\,[S]^{T}$
15

Figure 74. DSJNT3 Flow Chart

(i) TL01 Subroutine CPSD3 (figure 75)

This subroutine calculates the deflection cross-PSD matrices at NF frequencies.

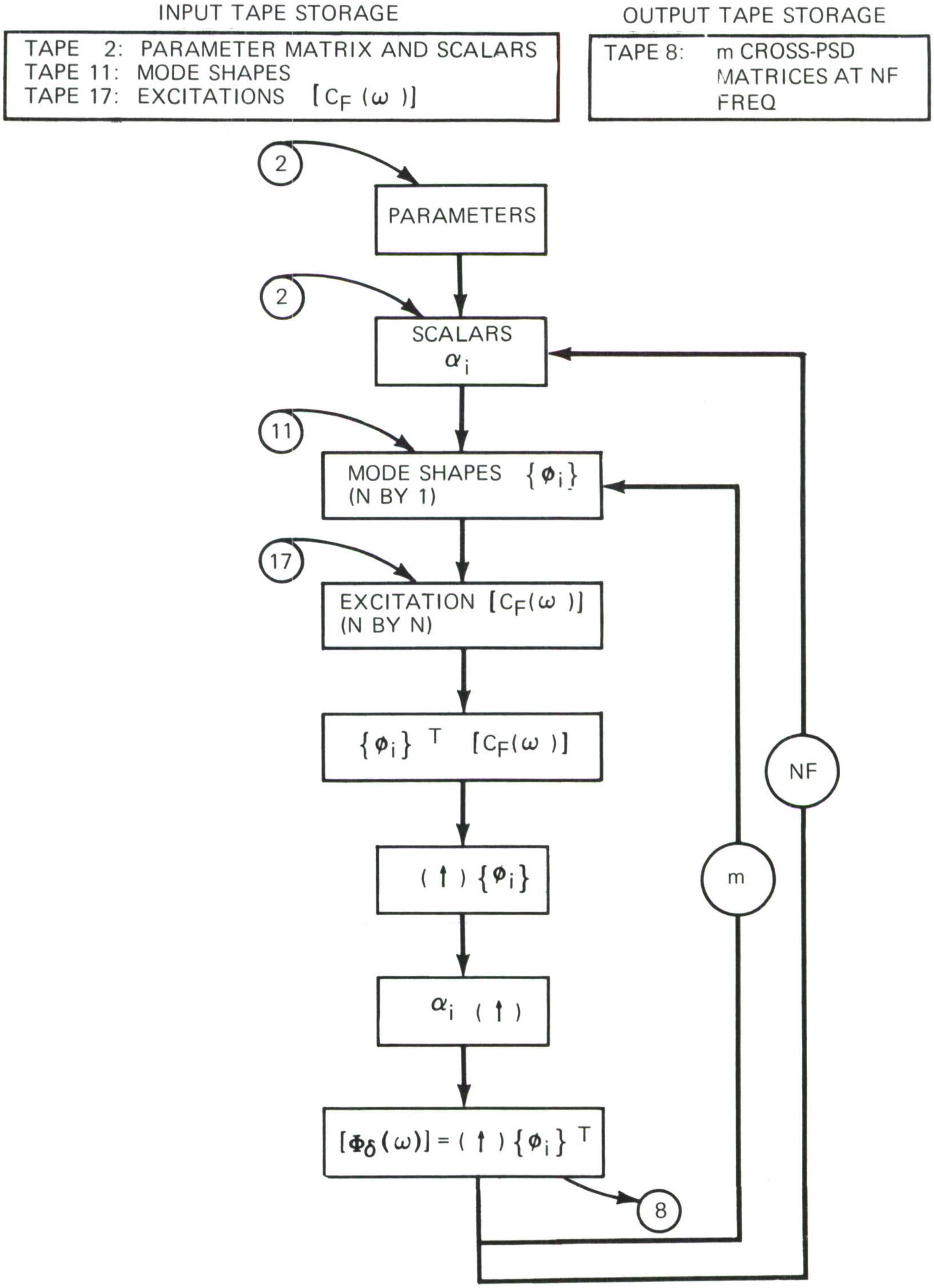

INPUT TAPE STORAGE
TAPE 2: PARAMETER MATRIX AND SCALARS
TAPE 11: MODE SHAPES
TAPE 17: EXCITATIONS [C_F (ω)]
OUTPUT TAPE STORAGE
TAPE 8: m CROSS-PSD MATRICES AT NF FREQ
2
PARAMETERS
2
SCALARS α_i
11
MODE SHAPES {φ_i} (N BY 1)
17
EXCITATION [C_F(ω)] (N BY N)
{φ_i}^T [C_F(ω)]
(↑) {φ_i}
α_i (↑)
[Φ_δ(ω)] = (↑) {φ_i}^T
8
m
NF

Figure 75. CPSD3 Flow Chart

(j) TL01 Subroutine SRESP3 (figure 76)

The stress cross-PSD matrices are calculated at NF frequencies.

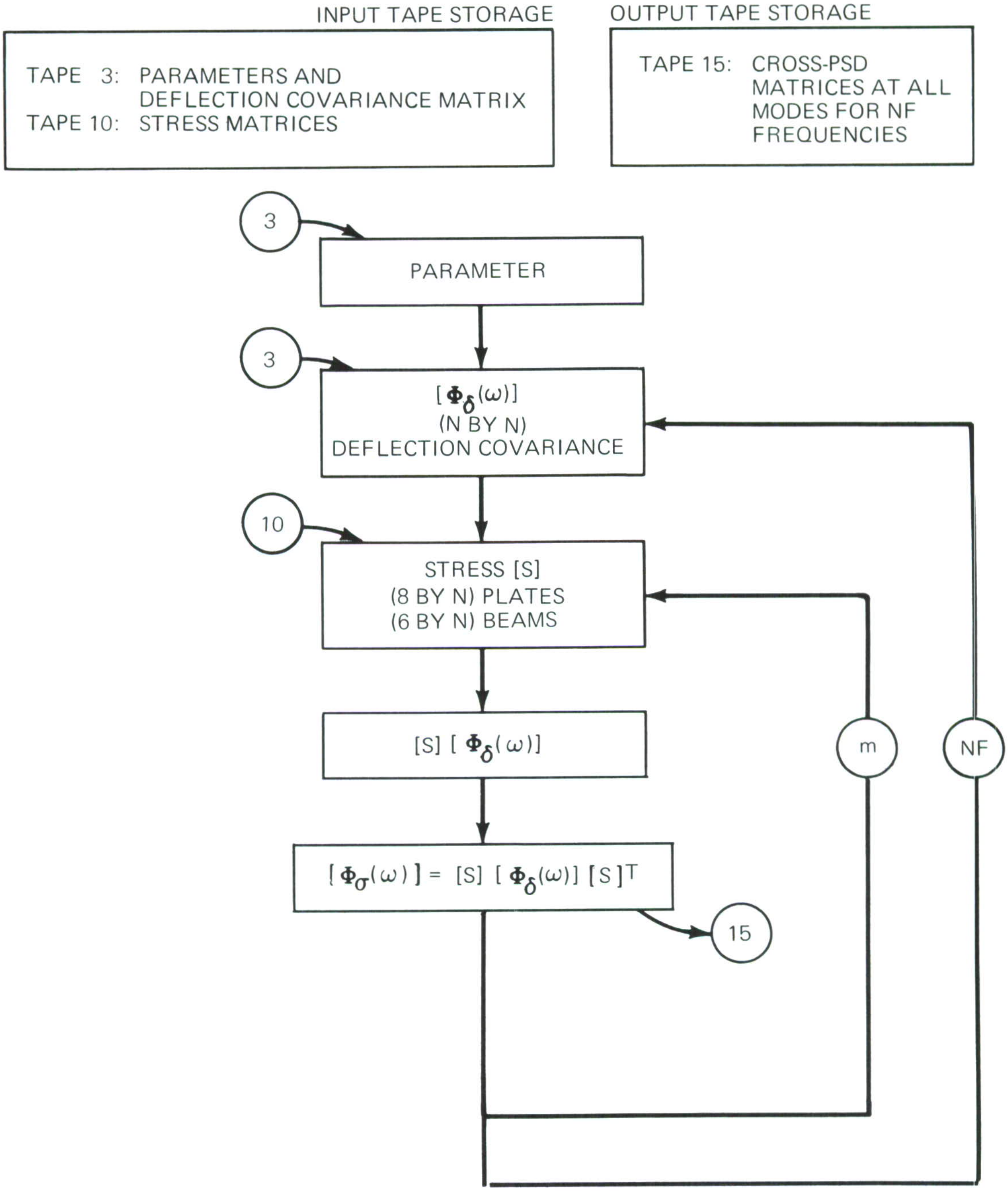

INPUT TAPE STORAGE
TAPE 3: PARAMETERS AND DEFLECTION COVARIANCE MATRIX
TAPE 10: STRESS MATRICES
OUTPUT TAPE STORAGE
TAPE 15: CROSS-PSD MATRICES AT ALL MODES FOR NF FREQUENCIES
3
PARAMETER
3
$[\Phi_\delta(\omega)]$
(N BY N)
DEFLECTION COVARIANCE
10
STRESS [S]
(8 BY N) PLATES
(6 BY N) BEAMS
$[S]\,[\Phi_\delta(\omega)]$
$[\Phi_\sigma(\omega)] = [S]\,[\Phi_\delta(\omega)]\,[S]^T$
15
m
NF

Figure 76. SRESP3 Flow Chart

APPENDIX I

TL01 DESCRIPTION AND LISTING

Matrix interpretive scheme TL01 is written in MAP assembly language. The program performs algebraic and manipulative operations on matrices.

The TL01 program instructions are executed from data inputs consisting of one data card for each TL01 instruction. Standard matrix storage is row-wise sequential as opposed to normal FORTRAN order.

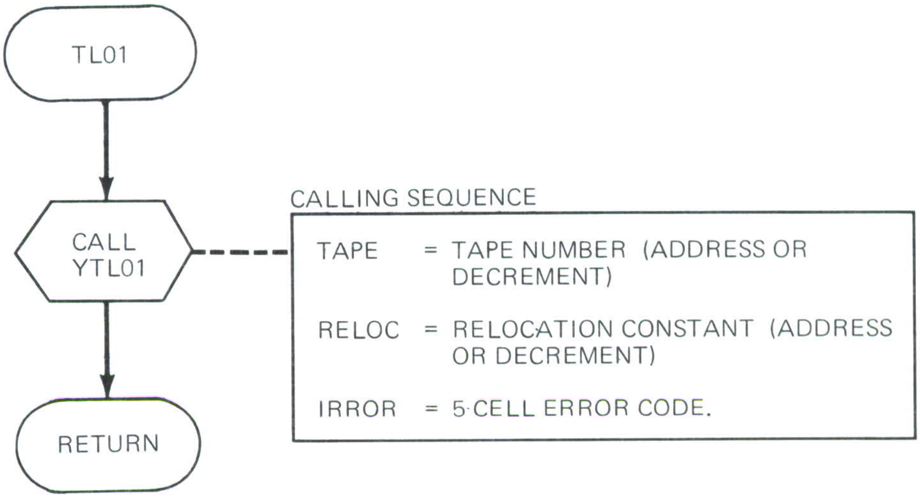
The required subroutines are as follows:

Subroutine	Function
KRD	Reads all card inputs
FSR	Controls forward tape record spacing
FSF	Controls forward tape file spacing
BSF	Controls backward tape file spacing
INV4DS	Calculates the inverse of a matrix
DATASB	Establishes data storage

The flow charts for the TL01 program are in figure 77.

This appendix contains the following listings:

Subroutine	Page
TL01 Listing	160
INV4DS	214
DATASB	225
KRD	226
BSF	233
FSF	235
FSR	237


TL01
CALL YTL01
RETURN

CALLING SEQUENCE

TAPE = TAPE NUMBER (ADDRESS OR DECREMENT)

RELOC = RELOCATION CONSTANT (ADDRESS OR DECREMENT)

IRROR = 5-CELL ERROR CODE.

Figure 77. TL01 Flow Chart

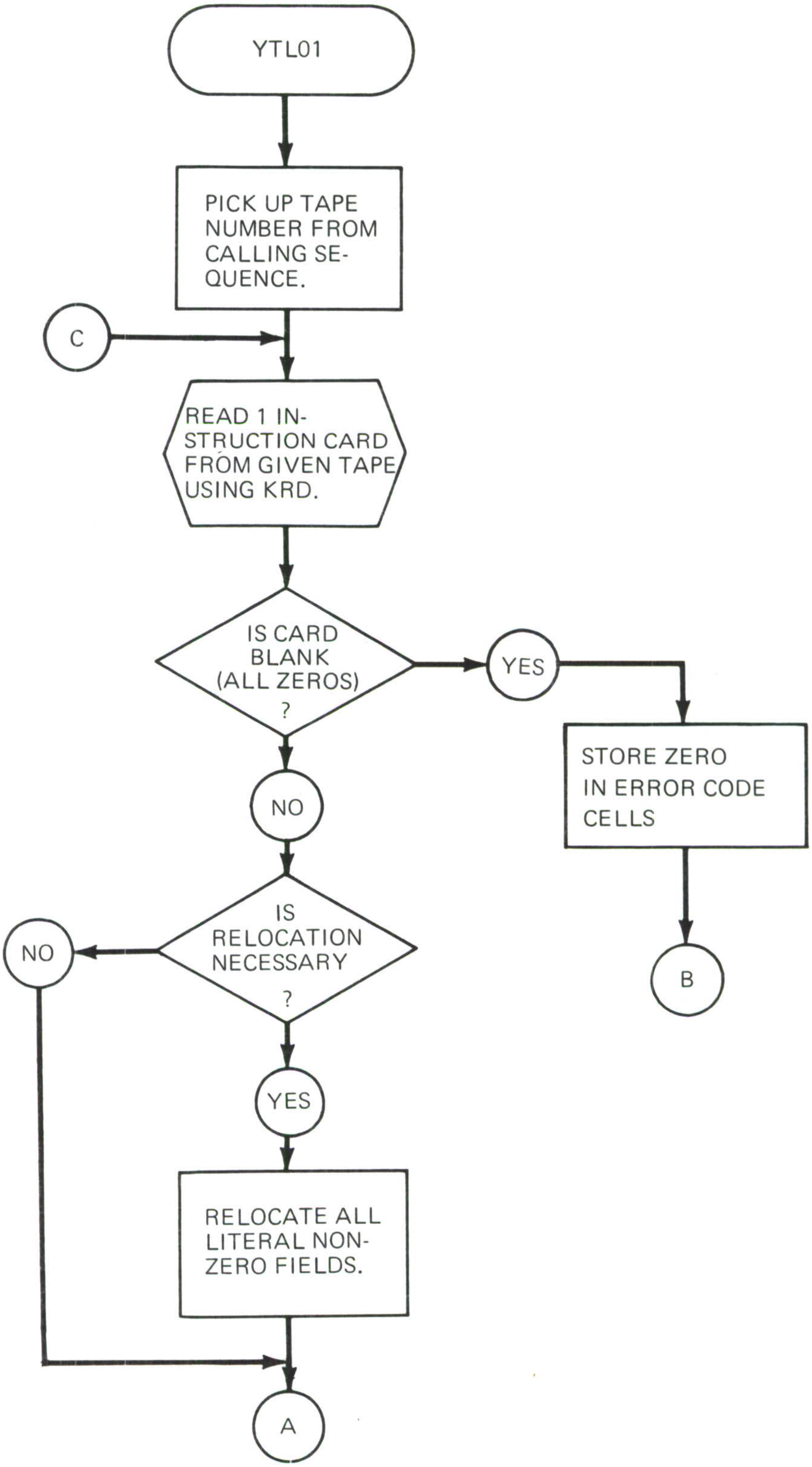

YTL01
PICK UP TAPE NUMBER FROM CALLING SE-QUENCE.
C
READ 1 IN-STRUCTION CARD FROM GIVEN TAPE USING KRD.
IS CARD BLANK (ALL ZEROS) ?
YES
STORE ZERO IN ERROR CODE CELLS
B
NO
IS RELOCATION NECESSARY ?
NO
YES
RELOCATE ALL LITERAL NON-ZERO FIELDS.
A

Figure 77—Continued

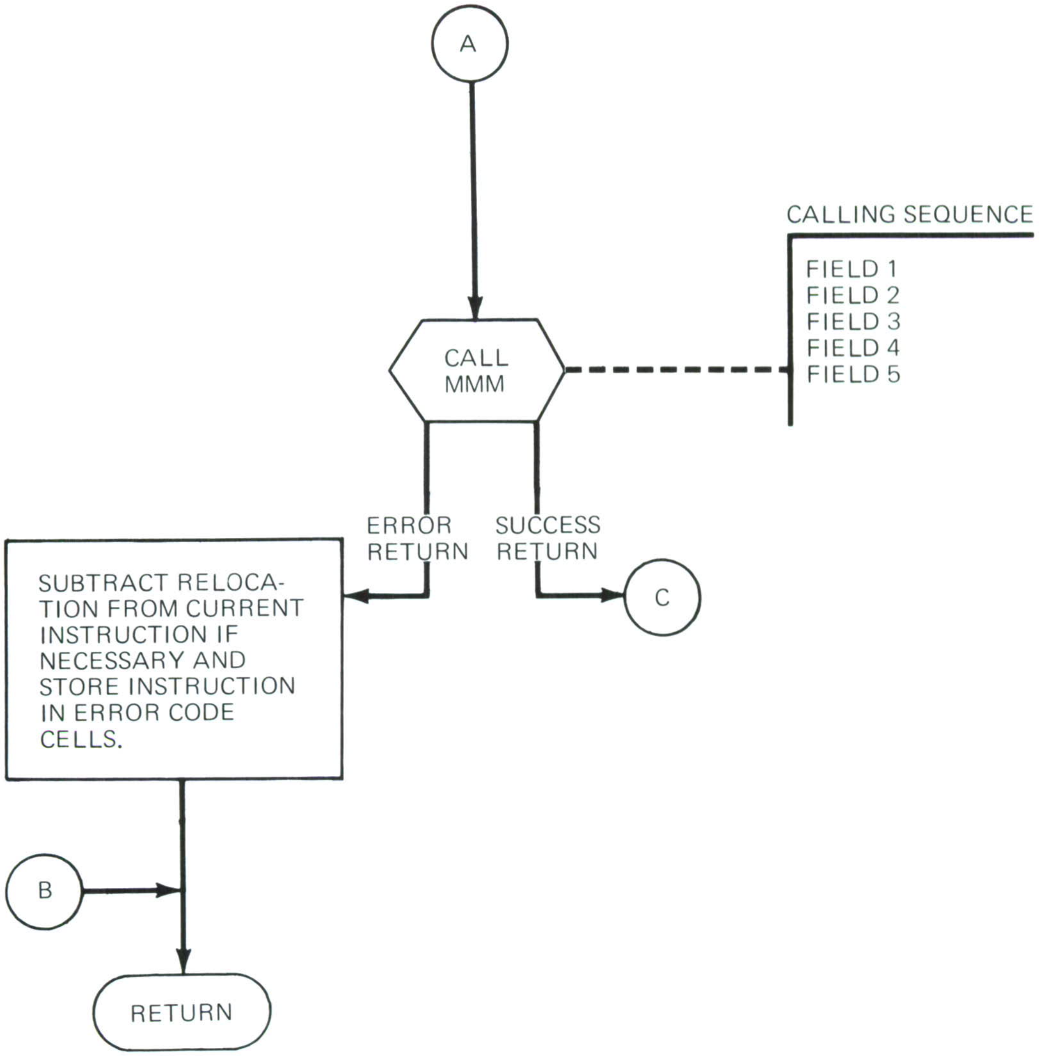

A
CALLING SEQUENCE
FIELD 1
FIELD 2
FIELD 3
FIELD 4
FIELD 5
CALL MMM
ERROR RETURN
SUCCESS RETURN
C
SUBTRACT RELOCATION FROM CURRENT INSTRUCTION IF NECESSARY AND STORE INSTRUCTION IN ERROR CODE CELLS.
B
RETURN

Figure 77–Continued

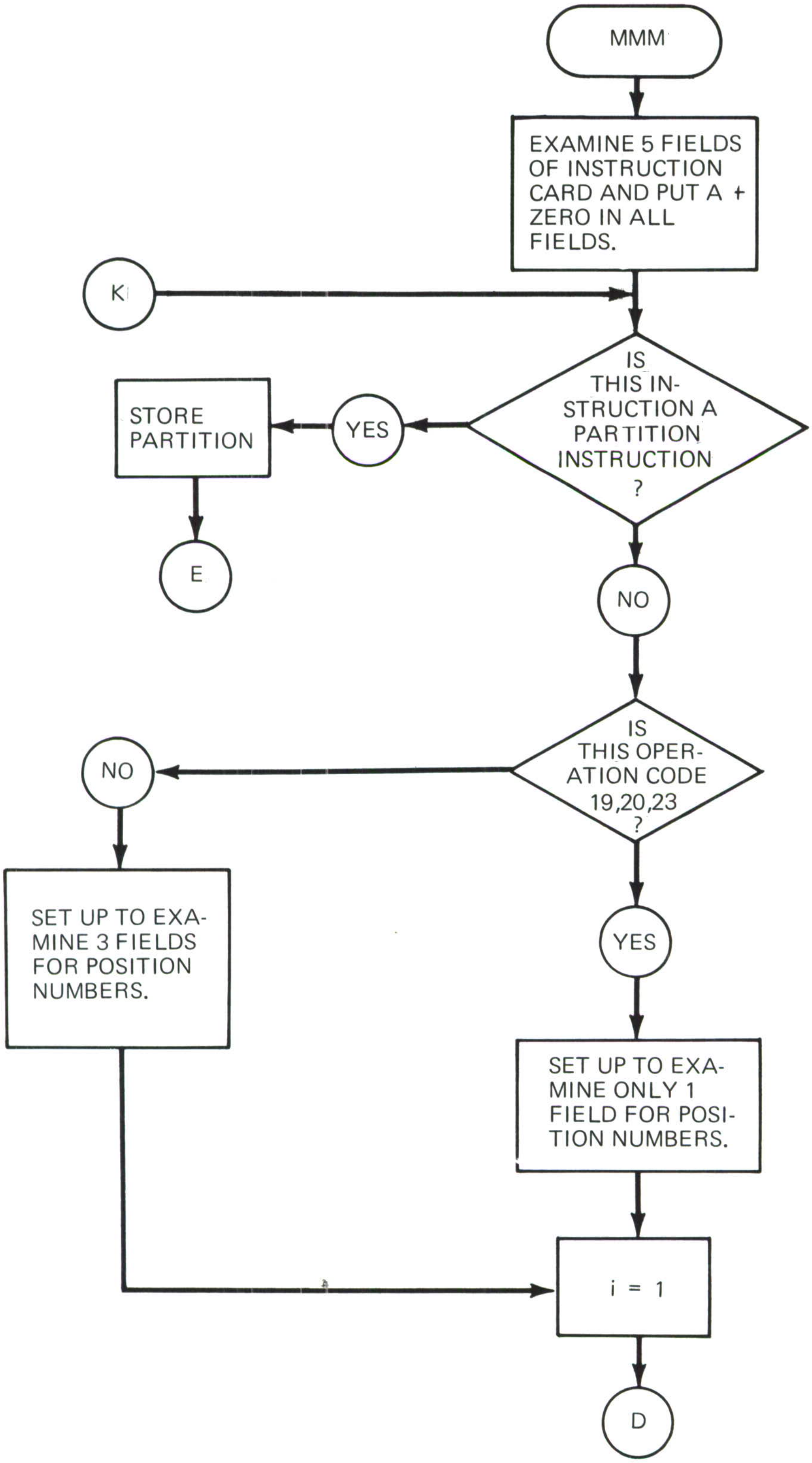

MMM
EXAMINE 5 FIELDS OF INSTRUCTION CARD AND PUT A + ZERO IN ALL FIELDS.
K
IS THIS INSTRUCTION A PARTITION INSTRUCTION ?
YES
STORE PARTITION
E
NO
IS THIS OPERATION CODE 19,20,23 ?
NO
SET UP TO EXAMINE 3 FIELDS FOR POSITION NUMBERS.
YES
SET UP TO EXAMINE ONLY 1 FIELD FOR POSITION NUMBERS.
i = 1
D

Figure 77—Continued

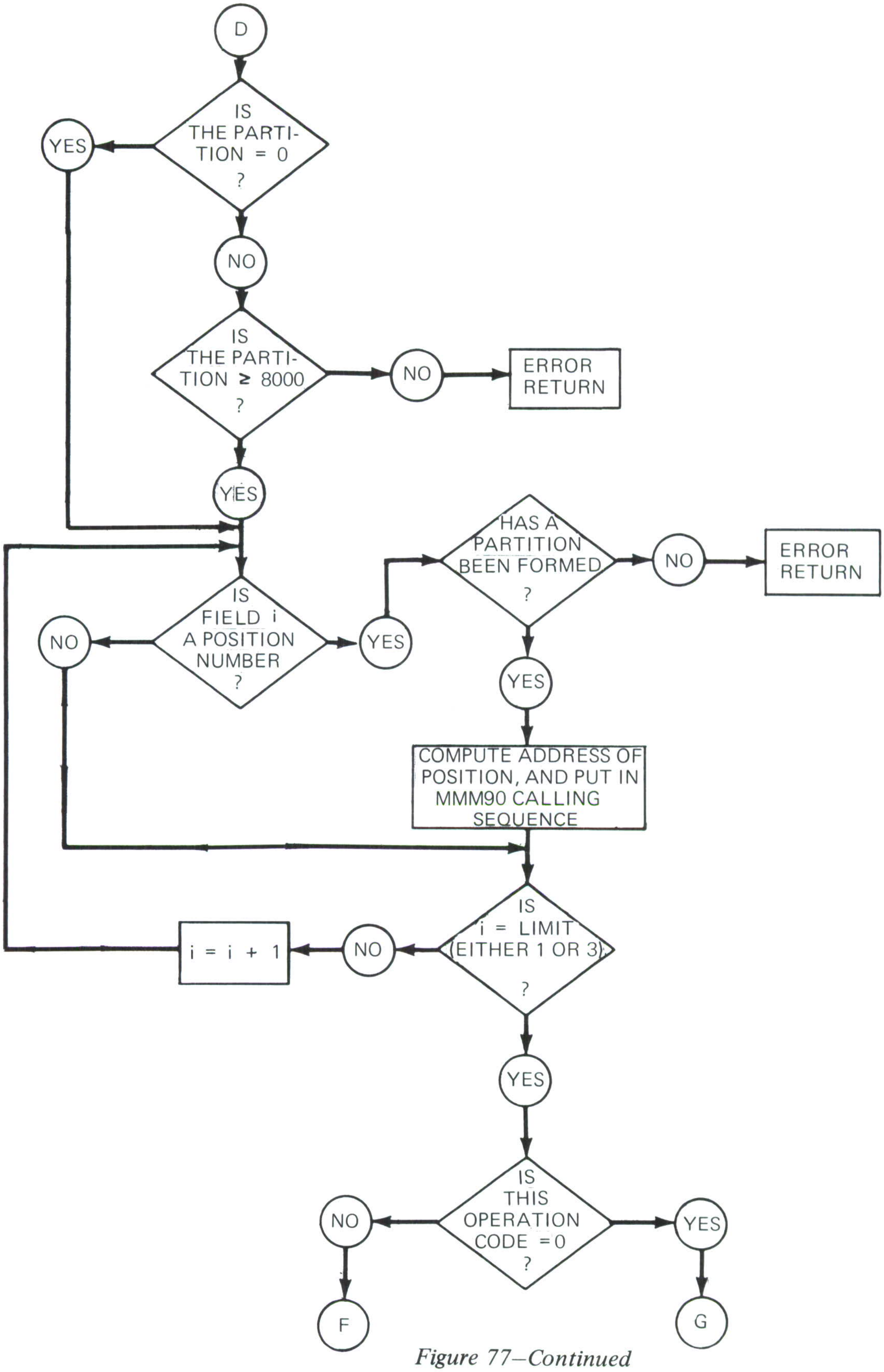

D
IS THE PARTITION = 0 ?
YES
NO
IS THE PARTITION ≥ 8000 ?
NO
ERROR RETURN
YES
HAS A PARTITION BEEN FORMED ?
NO
ERROR RETURN
IS FIELD i A POSITION NUMBER ?
NO
YES
YES
COMPUTE ADDRESS OF POSITION, AND PUT IN MMM90 CALLING SEQUENCE
IS i = LIMIT (EITHER 1 OR 3) ?
NO
i = i + 1
YES
IS THIS OPERATION CODE = 0 ?
NO
YES
F
G

Figure 77—Continued

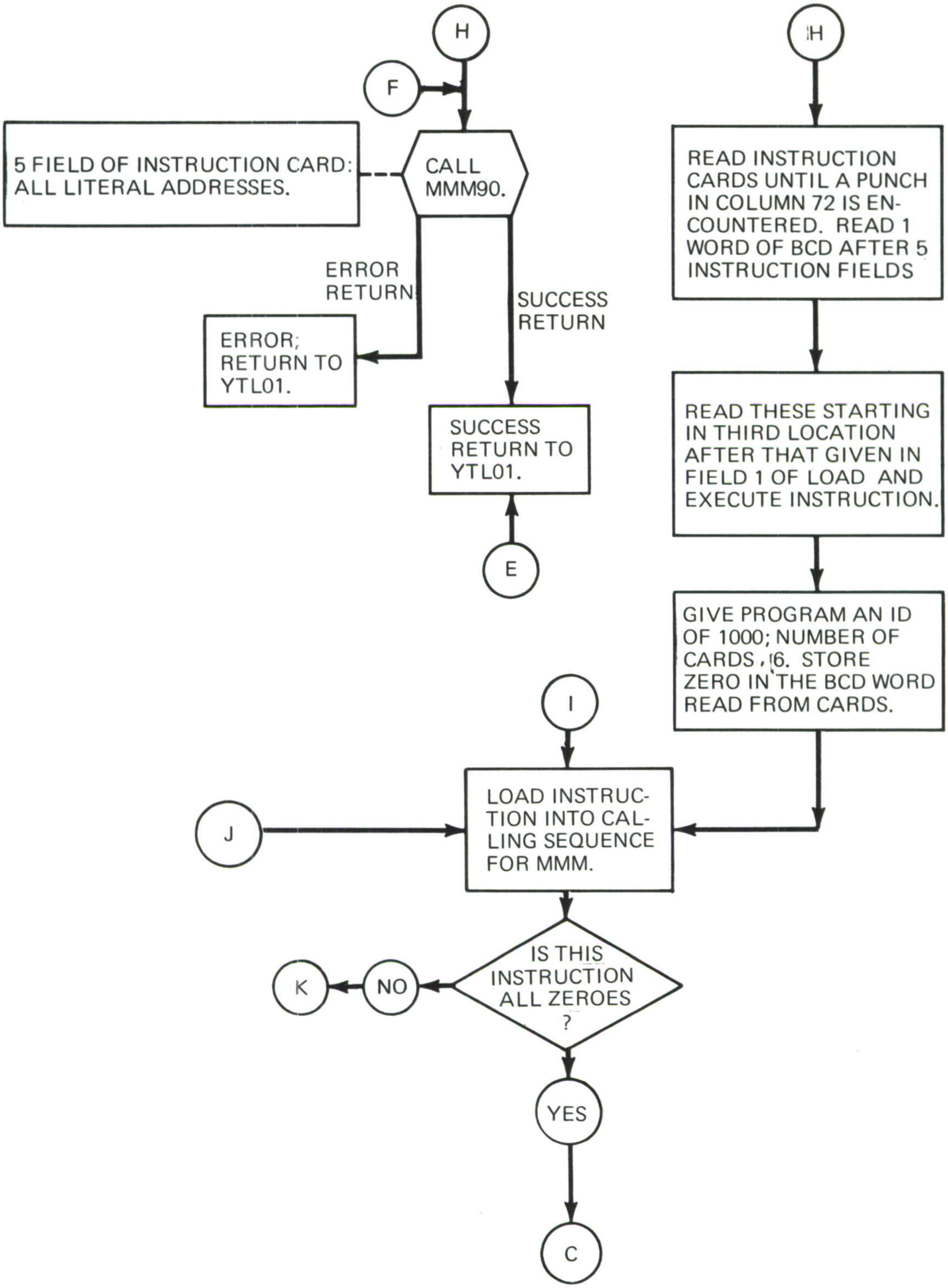

H
F
5 FIELD OF INSTRUCTION CARD: ALL LITERAL ADDRESSES.
CALL MMM90.
ERROR RETURN
SUCCESS RETURN
ERROR; RETURN TO YTL01.
SUCCESS RETURN TO YTL01.
E
H
READ INSTRUCTION CARDS UNTIL A PUNCH IN COLUMN 72 IS ENCOUNTERED. READ 1 WORD OF BCD AFTER 5 INSTRUCTION FIELDS
READ THESE STARTING IN THIRD LOCATION AFTER THAT GIVEN IN FIELD 1 OF LOAD AND EXECUTE INSTRUCTION.
GIVE PROGRAM AN ID OF 1000; NUMBER OF CARDS, 16. STORE ZERO IN THE BCD WORD READ FROM CARDS.
I
J
LOAD INSTRUCTION INTO CALLING SEQUENCE FOR MMM.
IS THIS INSTRUCTION ALL ZEROES ?
NO
K
YES
C

Figure 77—Continued

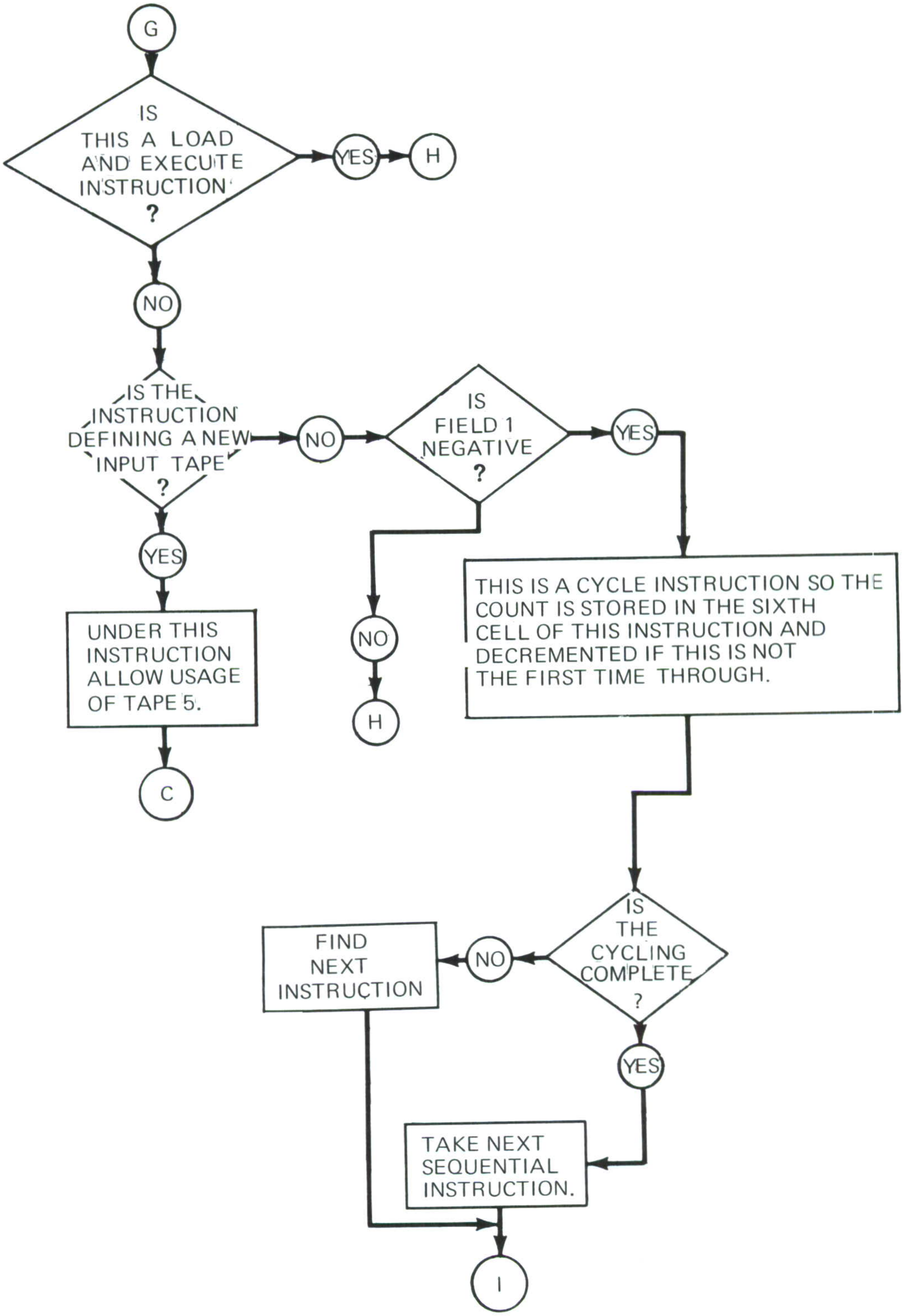

G
IS THIS A LOAD AND EXECUTE INSTRUCTION ?
YES
H
NO
IS THE INSTRUCTION DEFINING A NEW INPUT TAPE ?
NO
IS FIELD 1 NEGATIVE ?
YES
YES
UNDER THIS INSTRUCTION ALLOW USAGE OF TAPE 5.
C
NO
H
THIS IS A CYCLE INSTRUCTION SO THE COUNT IS STORED IN THE SIXTH CELL OF THIS INSTRUCTION AND DECREMENTED IF THIS IS NOT THE FIRST TIME THROUGH.
IS THE CYCLING COMPLETE ?
NO
FIND NEXT INSTRUCTION
YES
TAKE NEXT SEQUENTIAL INSTRUCTION.
I

Figure 77–Continued

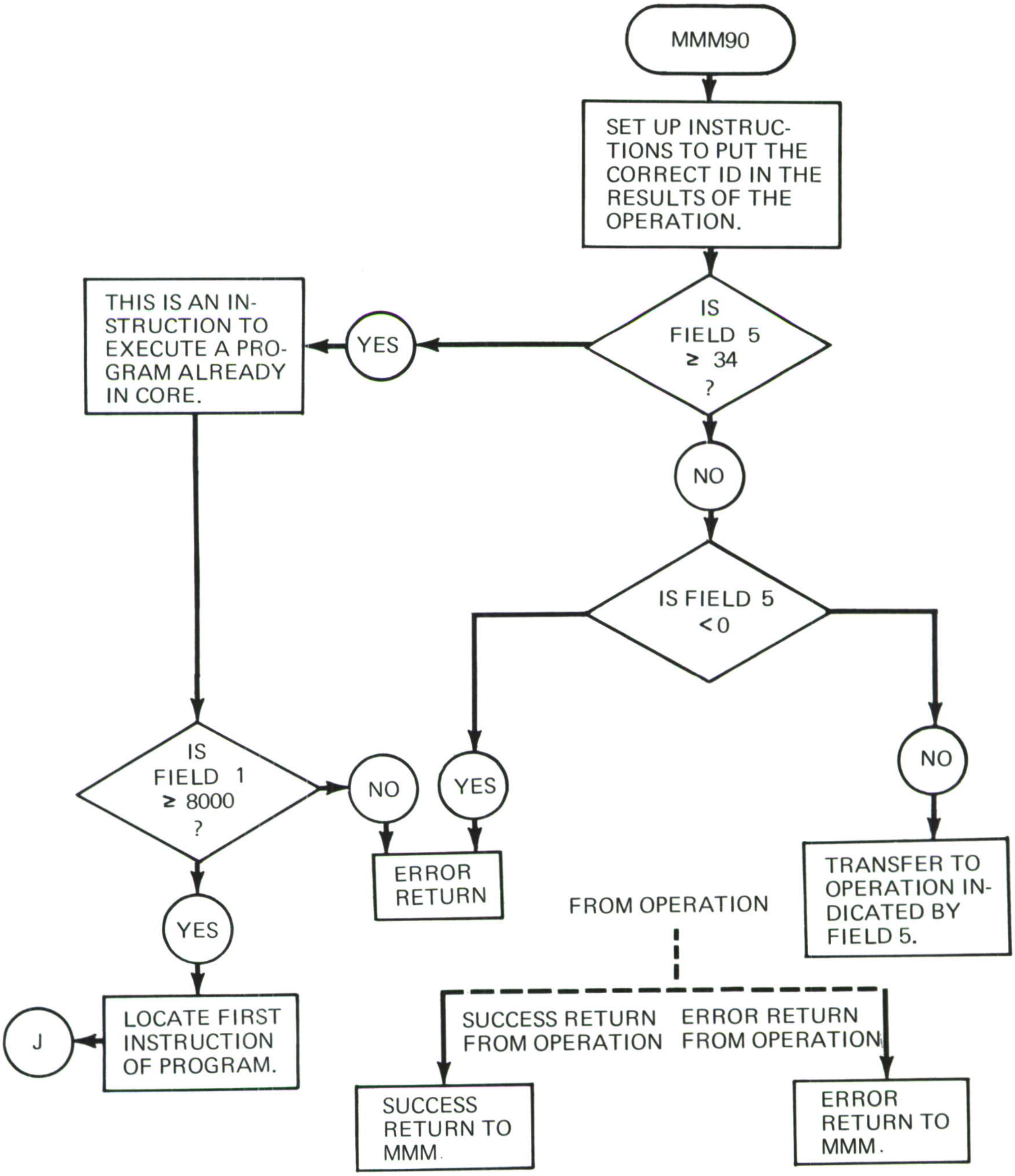

MMM90
SET UP INSTRUCTIONS TO PUT THE CORRECT ID IN THE RESULTS OF THE OPERATION.
IS FIELD 5 ≥ 34 ?
YES
THIS IS AN INSTRUCTION TO EXECUTE A PROGRAM ALREADY IN CORE.
NO
IS FIELD 5 <0
YES
NO
IS FIELD 1 ≥ 8000 ?
NO
ERROR RETURN
TRANSFER TO OPERATION INDICATED BY FIELD 5.
YES
FROM OPERATION
LOCATE FIRST INSTRUCTION OF PROGRAM.
J
SUCCESS RETURN FROM OPERATION
ERROR RETURN FROM OPERATION
SUCCESS RETURN TO MMM.
ERROR RETURN TO MMM.

Figure 77–Concluded

TL01 LISTING

```
$IBMAP HELP     DECK
*               SUBROUTINE TO ACT AS TL01MN
       ENTRY    TL01
 TL01  SXA      SAVE4,4
       CLA      3,4
       STA      SUBR+3
       CLA      ADRSA
       SUB      RELOC1
       ADD*     4,4
       STO      RELOC
       CLA      5,4
       STA      SUBR+5
 SUBR  CALL     YTL01(0,RELOC,0)
 SAVE4 AXT      0,4
       TRA      6,4
 ADRSA PZE      DATA
RELOC1 PZE      8000
RELOC  PZE      0
       END
```

```
$IBMAP YTLOSB  3200,DECK,M94/2                                          YTL00000
*YTL01          **** YTL01 7094 IBSYS ASSEMBLY,  AUGUST, 1967  ****     YTL00010
*                                                                         L00020
*                                                                         .00030
*                                                                       YTL00040
*                                                                       YTL00050
*                                                                       YTL00060
*                                                                       YTL00070
*                                                                       YTL00080
*               SUBROUTINES MMM AND YTL01                               YTL00090
*                                                                       YTL00100
        ENTRY   YTL01                                                   YTL00110
*               CALL YTL01(NTAPE,NSHIFT,IRROR)                          YTL00120
*               DIMENSION IRROR(5)                                      YTL00130
*               CALLING SEQUENCE IS STRICTLY                            YTL00140
*               TO FORTRAN CONVENTIONS                                  YTL00150
*                                                                       YTL00160
        ENTRY   YTL01                                                   YTL00170
*               DUMMY ENTRY TO ELIMINATE POSSIBLE ERRORS                YTL00180
*                                                                       YTL00190
        ENTRY   MMM                                                     YTL00200
*               CALL MMM(XLOCA,XLOCB,XLOCC,NAMEC,NCODE)                 YTL00210
*                                                                       YTL00220
*                                                                       YTL00230
*               THESE ENTRY POINTS ARE FOR DUMP PURPOSES ONLY           YTL00240
*                                                                       YTL00250
*                                                                       YTL00260
        ENTRY   ERRCDE          ERROR CODE                              YTL00270
        ENTRY   TAPE            TAPE INFORMATION                        YTL00280
*                                                                       YTL00290
*                                                                       YTL00300
YTL01   TTR     YTL01                                                   YTL00310
*                                                                       YTL00320
YTL01   LMTM                                                            YTL00330
        EFTM                                                            YTL00340
        SXD     XR1,1                                                   YTL00350
        SXD     XR2,2                                                   YTL00360
        SXD     XR4,4                                                   YTL00370
        CAL     8                                                       YTL00380
        SLW     TMPFPT          SAVE CELL 8 FOR RESTORE                 YTL00390
        CAL     FPTTRA          SET UP FOR FL. PT. TRAP                 YTL00400
        SLW     8                                                       YTL00410
        STZ     CELL0           CLEAR CELL FOR STORING CELL 0           YTL00420
        STZ     ERRCDE          ZERO ERROR CODE                         YTL00430
        CAL     5,4                                                     YTL00440
        ACL     =5                                                      YTL00450
        STA     INS                                                     YTL00460
        CLA*    3,4             TAPE UNIT                               YTL00470
        SLW     TAP                                                     YTL00480
        TZE*    *+2             TAP=0                                   YTL00490
        CAS     =19                                                     YTL00500
        TRA     TOBIG           TAP GREATER THAN 22                     YTL00510
        TRA     *+1                                                     YTL00520
        SUB     =6                                                      YTL00530
        TNZ     YENT                                                    YTL00540
        CLA     =14             DO NOT ALLOW A READ OF TAPE 6           YTL00550
        STO     ERRCDE                                                  YTL00560
        TRA    YTER                                                    YTL00570
  TOBIG CLA    =13           ILLEGAL TAPE NO                           YTL00580
        TRA    *-3                                                     YTL00590
*                                                                      YTL00600
  YENT  CALL   KRD(LOC,=0,IRROR,=5,=10,=0,TAP)                         YTL00610
        CLA    IRROR                                                   YTL00620
        TZE    *+4                                                     YTL00630
        ADD    =100          KRD READ CODE                             YTL00640
        STO    ERRCDE                                                  YTL00650
        TRA    YTER                                                    YTL00660
        AXT    4,1                                                     YTL00670
        CLA    LOC                                                     YTL00680
        ADD    LOC+5,1                                                 YTL00690
        TIX    *-1,1,1                                                 YTL00700
        TZE    YTOUT         FINISHED                                  YTL00710
*                                                                      YTL00720
        LXD    XR4,4                                                   YTL00730
        CLA*   4,4           RELOCATION                                YTL00740
        TZE    YTEX                                                    YTL00750
        STO    YSHIFT                                                  YTL00760
*                                                                      YTL00770
*                                                                      YTL00780
  YTEX  CALL   MMM(LOC,LOC+1,LOC+2,LOC+3,LOC+4)YTER                    YTL00790
        TRA    YENT          NEXT CARD                                 YTL00800
*                                                                      YTL00810
  YTOUT AXT    5,2                                                     YTL00820
        STZ*   INS           CLEAR ERROR AREA                          YTL00830
        TIX    *-1,2,1                                                 YTL00840
  YEXIT LXD    XR1,1                                                   YTL00850
        LXD    XR2,2                                                   YTL00860
        LXD    XR4,4                                                   YTL00870
        CAL    TMPFPT        RESTORE CELL 8                            YTL00880
        SLW    8                                                       YTL00890
        TRA    6,4           SUCCESS RETURN                            YTL00900
*                                                                      YTL00910
  YTER  NZT    YSHIFT                                                  YTL00920
        TTR    YTER3+1       TRANSFER ON NO RELOCATION                 YTL00930
        AXT    3,1                                                     YTL00940
  YTER2 CLA    LOC+3,1                                                 YTL00950
        TZE    YTER3         TRANSFER ON BLANK FIELD                   YTL00960
        SSP                                                            YTL00970
        SUB    SMLTAP                                                  YTL00980
        TPL    YTER3         TRANSFER ON TAPE NUMBER                   YTL00990
        CLA    LOC+3,1                                                 YTL01000
        SSP                                                            YTL01010
        SUB    LOCORE                                                  YTL01020
        TMI    YTER3         TRANSFER ON POSITION NUMBER               YTL01030
        CAL    LOC+3,1                                                 YTL01040
        SUB    YSHIFT                                                  YTL01050
        STA    LOC+3,1       ORIGINAL ADDRESS                          YTL01060
  YTER3 TIX    YTER2,1,1                                               YTL01070
        CALL   .FWRD.(.UN06.,ERRPNT)               PRINT ERROR MESSAGE YTL01080
        CLA    ERRCDE                                                  YTL01090
        TSX    .FCNV.,4                                                YTL01100
        CLA    INSCNT                                                  YTL01110
        TSX    .FCNV.,4                                                YTL01120
        CALL   .FFIL.                                                  YTL01130
        CAL    KEY                                                     YTL01140
        TZE    NOTPRG                                                  YTL01150
        SUB    YSHIFT                                                  YTL01160
        STO     YMAA                                                    YTL01170
        CLA     INST               GET PHYSICAL INSTRUCTION             YTL01180
        SUB     KEY                IF ERROR DURING CORE PROG.           YTL01190
        XCA                                                             YTL01200
        ZAC                                                             YTL01210
        DVP     =6                                                      YTL01220
        STQ     PHYSCT             PHYSICAL COUNT                       YTL01230
        CALL    .FWRD.(.UN06.,PROGER)         FOR CORE PROGRAM ONLY     YTL01240
        CLA     PHYSCT                                                  YTL01250
        TSX     .FCNV.,4                                                YTL01260
        CALL    .FFIL.                                                  YTL01270
NOTPRG  CLA     LOC                                                     YTL01280
        ADM     LOC+1                                                   YTL01290
        ADM     LOC+2                                                   YTL01300
        ADM     LOC+3                                                   YTL01310
        ADM     LOC+4                                                   YTL01320
        TNZ     LDERR                                                   YTL01330
        CLA     MILYN              PUT 1,000,000, IN FIELD 5 WHEN ERROR YTL01340
        STO     LOC+4              WAS MADE WHEN THE CURRENT INSTR. IS ZERO YTL01350
 LDERR  AXT     5,1                                                     YTL01360
        AXT     5,2                                                     YTL01370
        CAL     LOC+5,1                                                 YTL01380
        SLW*    INS                LOAD CARD IN ERROR                   YTL01390
        TIX     *+1,1,1                                                 YTL01400
        TIX     *-3,2,1                                                 YTL01410
        NZT     KEY                                                     YTL01420
        TRA     YEXIT                                                   YTL01430
        STZ     ERRCDE                                                  YTL01440
        STZ     KEY                                                     YTL01450
PNTPRG  CALL    MMM(YMAA,=1,=0,=0,=20)PNTER                             YTL01460
        TRA     YEXIT                                                   YTL01470
PNTER   CALL    .FWRD.(.UN06.,CORERR)                                   YTL01480
        CLA     ERRCDE                                                  YTL01490
        TSX     .FCNV.,4                                                YTL01500
        CALL    .FFIL.                                                  YTL01510
        TRA     YEXIT                                                   YTL01520
*                                                                       YTL01530
        REM MMM   GENERAL MATRIX ROUTINE                                YTL01540
        REM CALLING SEQUENCE                                            YTL01550
*               CALL MMM(LA,LB,LC,NC,CODE)ERRRET                        YTL01560
        REM                                                             YTL01570
        REM CONTROL PACKAGE                                             YTL01580
        REM                                                             YTL01590
*                                                                       YTL01600
   MMM  LMTM                                                            YTL01610
        EFTM                                                            YTL01620
        NZT     FIRST                                                   YTL01630
        TRA     REST                                                    YTL01640
        CLA     ADRSDA                                                  YTL01650
        STA     LOCORE                                                  YTL01660
        ADD*    ADRSDA                                                  YTL01670
        SUB     =1                                                      YTL01680
        STA     HICORE                                                  YTL01690
        CLA*    ADRSDA                                                  YTL01700
        STA     MXDATA                                                  YTL01710
        CLA     HICORE                                                  YTL01720
        SUB     =63                                                     YTL01730
        STA     HIPROG                                                  YTL01740
        CLA     ADRSDA                                                  YTL01750
        ADD     =1                                                      YTL01760
```

```
       STA    *+1                                                       YTL01770
       CLA    **             LOWEST ABSOLUTE CORE ADD. REFERENCED       YTL01780
       STA    PROGLO                                                    YTL01790
       STZ    FIRST                                                     YTL01800
REST   SXD    IR1,1                                                     YTL01810
       SXD    IR2,2                                                     YTL01820
       SXD    IR3,3                                                     YTL01830
       SXD    IR4,4                                                     YTL01840
       SXD    IR5,5                                                     YTL01850
       SXD    IR6,6                                                     YTL01860
       SXD    IR7,7                                                     YTL01870
       STZ    MCROCT         COUNT FOR STORING RETURNS                  YTL01880
       STZ    KEY                                                       YTL01890
       CLA*   3,4            AA                                         YTL01900
       TNZ    *+2                                                       YTL01910
       SSP                                                              YTL01920
       STO    LOC                                                       YTL01930
       STO    YMAA                                                      YTL01940
       CLA*   4,4                                                       YTL01950
       TNZ    *+2                                                       YTL01960
       SSP                                                              YTL01970
       STO    LOC+1                                                     YTL01980
       STO    YMBB                                                      YTL01990
       CLA*   5,4            CC                                         YTL02000
       TNZ    *+2                                                       YTL02010
       SSP                                                              YTL02020
       STO    LOC+2                                                     YTL02030
       STO    YMCC                                                      YTL02040
       CLA*   6,4            NAME OF C                                  YTL02050
       TNZ    *+2                                                       YTL02060
       SSP                                                              YTL02070
       STO    LOC+3                                                     YTL02080
       STO    YMNC                                                      YTL02090
       CLA*   7,4                                                       YTL02100
       TNZ    *+2                                                       YTL02110
       SSP                                                              YTL02120
       STO    LOC+4                                                     YTL02130
       STO    YMOP                                                      YTL02140
*                                                                       YTL02150
YMIN   AXT    3,1                                                       YTL02160
YTA    NZT    LOC+3,1                                                   YTL02170
       TTR    YTB            ZERO FIELD                                 YTL02180
       CLA    LOC+3,1                                                   YTL02190
       SSP                                                              YTL02200
       SUB    SMLTAP                                                    YTL02210
       TPL    YTB                                                       YTL02220
       CLA    LOC+3,1                                                   YTL02230
       SSP                                                              YTL02240
       SUB    PROGLO                                                    YTL02250
       TMI    YTB                                                       YTL02260
       CAL    LOC+3,1                                                   YTL02270
       ADD    YSHIFT         RELOCATE CORE ADDRESSES                    YTL02280
       STA    LOC+3,1                                                   YTL02290
       STA    YMAA+3,1                                                  YTL02300
YTB    TIX    YTA,1,1                                                   YTL02310
       CLA    YMOP                                                      YTL02320
       TNZ    YMA            NOT OPERATION ZERO                         YTL02330
       CLA    YMAA                                                      YTL02340
       TNZ    YMA                                                       YTL02350
       CLA    YMBB                                                      YTL02360
```

```
        TMI     YMA                                                     YTL02370
        SUB     SMLTAP                                                  YTL02380
        TPL     YMA                                                     YTL02390
        CLA     YMBB                                                    YTL02400
        TZE     YMEXEC                                                  YTL02410
        STO     XMODE           FIELD 2 IS A PARTITION                  YTL02420
        STZ     PARTON          ZERO PARTON WHEN A PARTITION IS FORMED  YTL02430
        TSX     CHKRNG,4        CHECK TO SEE IF NO. IS                  YTL02440
        TRA     *+2             BETWEEN 8000 AND 32563                  YTL02450
        TRA     WHERE           OK ON PARTITION ADDRESS                 YTL02460
        CLA     =21                                                     YTL02470
        TRA     YMERR           TOO LOW OK TOO HI PARTITION             YTL02480
*                                                                       YTL02490
YMA     AXT     1,1                                                     YTL02500
        SXA     TEMP-1,1        3 FIELDS                                YTL02510
        CLA     YMOP                                                    YTL02520
        SUB     =19                                                     YTL02530
        TZE     YYY             CODE 19                                 YTL02540
        CLA     YMOP                                                    YTL02550
        SUB     =20                                                     YTL02560
        TZE     YYY             CODE 20                                 YTL02570
        CLA     YMOP                                                    YTL02580
        SUB     =23                                                     YTL02590
        TZE     YYY             CODE 23                                 YTL02600
        AXT     3,1                                                     YTL02610
        SXA     TEMP-1,1        1 FIELD FOR READ                        YTL02620
*                                                                       YTL02630
YYY     LXA     TEMP-1,1                                                YTL02640
        AXT     0,2                                                     YTL02650
        CLA     XMODE                                                   YTL02660
        STO     TEMP            PARTITION                               YTL02670
YMB     CLA     YMAA,2          PARAMETER                               YTL02680
        TMI     YMC                                                     YTL02690
        TZE     YMC                                                     YTL02700
        SUB     TOPPOS                                                  YTL02710
        TPL     YMC             NOT A POS. NO.                          YTL02720
        CLA     PARTON                                                  YTL02730
        TZE     *+3                                                     YTL02740
        CLA     =22             POSITION REFERENCED WITHOUT PARTITION   YTL02750
        TRA     YMERR                                                   YTL02760
        CLA     YMAA,2                                                  YTL02770
        SUB     =1                                                      YTL02780
        TZE     YMD             POSITION NO. IS ONE                     YTL02790
        PAX     0,4                                                     YTL02800
YME     CAL     TEMP                                                    YTL02810
        ADD     =1                                                      YTL02820
        SLW     TEMP-1          ADDRESS OF M                            YTL02830
        ADD     =1                                                      YTL02840
        SLW     TEMP-2          ADDRESS OF N                            YTL02850
        LDQ*    TEMP-1                                                  YTL02860
        MPY*    TEMP-2                                                  YTL02870
        TNZ     WAYTOB                                                  YTL02880
        STQ     TEMP-1                                                  YTL02890
        XCA                                                             YTL02900
        TZE     GOODDM                                                  YTL02910
        TMI     *+5                                                     YTL02920
        CAS     MXDATA                                                  YTL02930
        TRA     *+3                                                     YTL02940
        TRA     GOODDM                                                  YTL02950
        TRA     GOODDM                                                  YTL02960
```

```
WAYTOB STZ     JEMP-1                                       YTL02970
       LDQ     YMAA,2                                       YTL02980
       MPY     THOUSN                                       YTL02990
       STQ     TEMP                                         YTL03000
       CLA     YMAA,2                                       YTL03010
       SXA     TEMP-1,4                                     YTL03020
       SUB     TEMP-1                                       YTL03030
       ADD     TEMP                                         YTL03040
       ADD     =2000000                                     YTL03050
       TRA     YMERR                                        YTL03060
GOODDM CLA     TEMP-1                                       YTL03070
       ACL     =3                                           YTL03080
       ACL     TEMP                                         YTL03090
       SLW     TEMP          NEXT MATRIX                    YTL03100
       TIX     YME,4,1                                      YTL03110
YMD    CLA     TEMP                                         YTL03120
       STO     YMAA,2        INSERT ADDRESS                 YTL03130
YMC    TXI     *+1,2,-1                                     YTL03140
       CLA     XMODE                                        YTL03150
       TIX     YMB-1,1,1                                    YTL03160
*                                                           YTL03170
*              SEPARATION OF ZERO OP. CODES                 YTL03180
*                                                           YTL03190
YSEP   CLA     YMOP                                         YTL03200
       TNZ     YMEXEC        NOT OP. CODE 0                 YTL03210
SEPA   CLA     YMBB                                         YTL03220
       SSP                                                  YTL03230
       ADD     YMCC                                         YTL03240
       ADM     YMNC                                         YTL03250
       TNZ     SEPC                                         YTL03260
       CLA     YMAA                                         YTL03270
       SUB     SMLTAP                                       YTL03280
       TPL     SEPB          TRANSFER OF CONTROL            YTL03290
       TTR     MLOAD         LOAD PROGRAM                   YTL03300
SEPB   CLA     YMAA                                         YTL03310
       TSX     TP,4                                         YTL03320
       STO     TAP                                          YTL03330
       XCA                                                  YTL03340
       TZE     *+3                                          YTL03350
       CLA     =13                                          YTL03360
       TRA     YMERR                                        YTL03370
       XCA                                                  YTL03380
       CAS     =5            ALLOW 5                        YTL03390
       TRA     *+2                                          YTL03400
       TRA     WHERE                                        YTL03410
       STO     TAPE                                         YTL03420
       TSX     TPCK,4                                       YTL03430
       TRA     WHERE                                        YTL03440
SEPC   CLA     YMBB                                         YTL03450
       SSP                                                  YTL03460
       ADD     YMCC                                         YTL03470
       TNZ     YMEXEC                                       YTL03480
       CLA     YMAA                                         YTL03490
       TMI     CYCLE+2                                      YTL03500
       CAS     LOCORE                                       YTL03510
       TRA     MLOAD                                        YTL03520
       TRA     MLOAD                                        YTL03530
       TRA     CYCLE                                        YTL03540
*                                                           YTL03550
MLOAD  CLA     YMAA                                         YTL03560
```

```
        CAS    LOCORE           PROGRAM MUST LOAD BETWEEN                         YTL03570
        TRA    *+4              ADRSDA AND 32500,INCLUSIVE                        YTL03580
        TRA    *+3                                                                YTL03590
        CLA    =23                                                                YTL03600
        TRA    YMERR                                                              YTL03610
        CAS    HIPROG                                                             YTL03620
        TRA    *-3                                                                YTL03630
        TRA    *+1                                                                YTL03640
        ADD    =3                                                                 YTL03650
        STA    SEPD+3                                                             YTL03660
        CLA    TAP                                                                YTL03670
        STA    SEPE             CURRENT TAPE                                      YTL03680
SEPD    CALL   KRD(**,=1,IRROR,=5,=10,=1,SEPE)                                    YTL03690
        STO    TEMP             CARD COUNT                                        YTL03700
        CLA    IRROR            KRD ERROR CODE                                    YTL03710
        TZE    CONT1                                                              YTL03720
        XCA                                                                       YTL03730
        MPY    THOUSN                                                             YTL03740
        XCA                                                                       YTL03750
        ADD    TEMP                                                               YTL03760
        ADD    MILYN                                                              YTL03770
        TRA    YMERR                                                              YTL03780
 CONT1  CLA    YMAA             STUFF ADDRESS OF DIMENSION                        YTL03790
        ADD    =1                                                                 YTL03800
        STA    NOINST           ROW DIMENSION                                     YTL03810
        ADD    =1                                                                 YTL03820
        STA    ALWYS6                                                             YTL03830
        CLA    TEMP                                                               YTL03840
NOINST  STO    **                                                                 YTL03850
        CLA    =6                                                                 YTL03860
ALWYS6  STO    **                                                                 YTL03870
        CLA    YMNC                                                               YTL03880
        TZE    *+3                                                                YTL03890
        STO*   YMAA                                                               YTL03900
        TRA    SEPF                                                               YTL03910
        CLA    THOUSN                                                             YTL03920
        STO*   YMAA                                                               YTL03930
        CLA    SEPD+3                                                             YTL03940
        STO    INST             NEXT INSTRUCTION                                  YTL03950
        CLA    INSCNT                                                             YTL03960
        ADD    =1                                                                 YTL03970
        STO    INSCNT                                                             YTL03980
        CLA    KEY                                                                YTL03990
        STA    SAVKEY                                                             YTL04000
        TNZ    *+4                                                                YTL04010
        CLA    YMAA             FROM CARD PROGRAM                                 YTL04020
        STO    KEY                                                                YTL04030
        TRA    SEPF                                                               YTL04040
        CLA    YMAA             FROM CORE PROGRAM                                 YTL04050
        STO    KEY                                                                YTL04060
        TRA    SUBLNK           STORE RETURN LOCATION                             YTL04070
*                                                                                 YTL04080
  SEPF  LDQ*   NOINST                                                             YTL04090
        MPY    =6                                                                 YTL04100
        XCA                                                                       YTL04110
        PAX    0,1                                                                YTL04120
        ADD    SEPD+3                                                             YTL04130
        STA    GETFLD                                                             YTL04140
        AXT    5,2                                                                YTL04150
GETFLD  CLA    **,1                                                               YTL04160
```

```
        TNZ     *+2                                                     YTL04170
        STZ*    GETFLD                                                  YTL04180
        TXI     *+1,1,-1                                                YTL04190
        TIX     GETFLD,2,1                                              YTL04200
        STZ*    GETFLD                                                  YTL04210
        TIX     GETFLD-1,1,1                                            YTL04220
        CLA     YMNC                                                    YTL04230
        TNZ     WHERE                                                   YTL04240
        STZ     INSCNT                                                  YTL04250
*                                                                       YTL04260
        TTR     COREX                                                   YTL04270
*                                                                       YTL04280
CYCLE   SUB     THOUSN                                                  YTL04290
        STO     YMAA                                                    YTL04300
        CLA     KEY                                                     YTL04310
        TNZ     *+3                                                     YTL04320
        CLA     =24                                                     YTL04330
        TRA     YMERR           CANNOT CYCLE FROM TAPE                  YTL04340
        CLA     YMNC            COUNT                                   YTL04350
        TZE     *+4             ZERO COUNT                              YTL04360
        TPL     *+3                                                     YTL04370
NEGCT   CLA     =25                                                     YTL04380
        TRA     YMERR           NEGATIVE COUNT                          YTL04390
        STO     TEMP                                                    YTL04400
        SUB     PROGLO                                                  YTL04410
        TMI     CYAT                                                    YTL04420
        CLA     YMNC                                                    YTL04430
        ADD     YSHIFT                                                  YTL04440
        STA     YMNC                                                    YTL04450
        CLA*    YMNC                                                    YTL04460
        TZE     *+2             ZERO COUNT                              YTL04470
        TMI     NEGCT                                                   YTL04480
        STO     TEMP            COUNT IS IN TEMP                        YTL04490
        SUB     THOUSN                                                  YTL04500
        TMI     CYA                                                     YTL04510
        CLA     =26                                                     YTL04520
        TRA     YMERR           COUNT MUST BE LTE TO 1000               YTL04530
CYAT    CLA     YMNC                                                    YTL04540
        SUB     THOUSN                                                  YTL04550
        TMI     *+2                                                     YTL04560
        TRA     CYAT-2                                                  YTL04570
CYA     CLA     INST                                                    YTL04580
        SUB     =1              ADDRESS OF SUB-COUNT                    YTL04590
        STO     TEMP-1                                                  YTL04600
        CAL*    TEMP-1                                                  YTL04610
        ANA     =0077777000000                                          YTL04620
        TNZ     CYB             PRIMED                                  YTL04630
        CLA     TEMP                                                    YTL04640
        STO*    TEMP-1          PRIME                                   YTL04650
        ALS     18              PUT TOTAL COUNT IN DECREMENT            YTL04660
        ORS*    TEMP-1                                                  YTL04670
CYB     CLA*    TEMP-1                                                  YTL04680
        ANA     =0000000077777                                          YTL04690
        TZE     COUT                                                    YTL04700
        SUB     =1                                                      YTL04710
        TZE     COUT                                                    YTL04720
        STA*    TEMP-1          NEW SUB-COUNT                           YTL04730
        CLA     YMAA                                                    YTL04740
        SUB     =1                                                      YTL04750
        XCA                                                             YTL04760
```

```
       MPY     =6                                                       YTL04770
       XCA                                                              YTL04780
       ADD     INST                                                     YTL04790
       STO     INST           NEXT CARD                                 YTL04800
       STO     SAVINS         INST. LOC. FOR RETURN ARRAY               YTL04810
       TRA     COUT+1                                                   YTL04820
*                                                                       YTL04830
 COUT  STZ*    TEMP-1                                                   YTL04840
       CLA     INSCNT                                                   YTL04850
       ADD     =1                                                       YTL04860
       STO     INSCNT                                                   YTL04870
       TTR     COREX                                                    YTL04880
*                                                                       YTL04890
 COREX AXT     5,1                                                      YTL04900
       CLA*    INST           LOAD CARD                                 YTL04910
       STO     YMAA+5,1                                                 YTL04920
       STO     LOC+5,1        FOR ERROR TRACE                           YTL04930
       CAL     INST                                                     YTL04940
       ADD     =1                                                       YTL04950
       SLW     INST                                                     YTL04960
       TIX     COREX+1,1,1                                              YTL04970
       CAL     INST                                                     YTL04980
       ADD     =1                                                       YTL04990
       SLW     INST           NEXT CARD                                 YTL05000
       SLW     SAVINS                                                   YTL05010
       AXT     5,1                                                      YTL05020
       PXD     0,0                                                      YTL05030
       ADM     YMAA+5,1                                                 YTL05040
       TIX     *-1,1,1                                                  YTL05050
       TNZ     YMIN                                                     YTL05060
       CLA     MCROCT                                                   YTL05070
       TNZ     *+3                                                      YTL05080
       STZ     KEY                                                      YTL05090
       TRA     WHERE+2        GO OUT OF CORE PROGRAM                    YTL05100
       PAC     0,1            SET UP RETURN LOCATION                    YTL05110
       CAL     RETURN-1,1                                               YTL05120
       STA     INST           NEXT INSTRUCTION                          YTL05130
       ARS     18                                                       YTL05140
       STA     XMODE          PARTITION                                 YTL05150
       CAL     PRGLOC-1,1     PROGRAM LOCATION                          YTL05160
       STA     KEY                                                      YTL05170
       ARS     18                                                       YTL05180
       STA     INSCNT                                                   YTL05190
       CAL     MCROCT                                                   YTL05200
       SUB     =1                                                       YTL05210
       SLW     MCROCT                                                   YTL05220
       TRA     COREX                                                    YTL05230
*                                                                       YTL05240
 WHERE CLA     INSCNT         INCREMENT COUNT OF                        YTL05250
       ADD     =1             INSTRUCTIONS SUCCESSFULLY                 YTL05260
       STO     INSCNT         COMPLETED                                 YTL05270
       CLA     KEY                                                      YTL05280
       TZE     YMEXIT                                                   YTL05290
       TTR     COREX                                                    YTL05300
*                                                                       YTL05310
YMEXEC TSX     MMM90,4                                                  YTL05320
 YMAA  PZE                                                              YTL05330
 YMBB  PZE                                                              YTL05340
 YMCC  PZE                                                              YTL05350
 YMNC  PZE                                                              YTL05360
 YMOP   PZE                                                              YTL05370
        TTR     YMERR                                                    YTL05380
        TTR     WHERE                                                    YTL05390
*                                                                        YTL05400
YMEXIT  LXD     IR4,4                                                    YTL05410
        LXD     IR2,2                                                    YTL05420
        LXD     IR3,3                                                    YTL05430
        LXD     IR1,1                                                    YTL05440
        LXD     IR5,5                                                    YTL05450
        LXD     IR6,6                                                    YTL05460
        LXD     IR7,7                                                    YTL05470
        TRA     9,4             SUCCESS                                  YTL05480
*                                                                        YTL05490
 YMERR  NZT     ERRCDE          DO NOT STORE CODE IF PREVIOUSLY DONE     YTL05500
        STO     ERRCDE                                                   YTL05510
        LXD     IR4,4                                                    YTL05520
        TXI     YMEXIT+1,4,1    ERROR RETURN TO 6,4                      YTL05530
*                                                                        YTL05540
*                                                                        YTL05550
 MMM90  SXD     SPOT4,4         STORE PARAMETERS                         YTL05560
        CLA 1,4                                                          YTL05570
        ADD     =1                                                       YTL05580
        STA MMMA                                                         YTL05590
        ADD     =1                                                       YTL05600
        STA MMMA+2                                                       YTL05610
        ADD     =1                                                       YTL05620
        STO LA11                                                         YTL05630
        CLA 2,4                                                          YTL05640
        ADD     =1                                                       YTL05650
        STA MMMB                                                         YTL05660
        ADD     =1                                                       YTL05670
        STA MMMB+2                                                       YTL05680
        ADD     =1                                                       YTL05690
        STO LB11                                                         YTL05700
        CLA 3,4                                                          YTL05710
        STA     LOCC                                                     YTL05720
        ADD     =1                                                       YTL05730
        STA     LOCMC                                                    YTL05740
        ADD     =1                                                       YTL05750
        STA     LOCNC                                                    YTL05760
        ADD     =1                                                       YTL05770
        STO LC11                                                         YTL05780
        STZ     ANULL                                                    YTL05790
        STZ     BNULL                                                    YTL05800
        CLA     WDMNL                                                    YTL05810
        CAS*    LA11                                                     YTL05820
        TRA     *+2                                                      YTL05830
        STO     ANULL           A IS NULL                                YTL05840
        CAS*    LB11                                                     YTL05850
        TRA     *+2                                                      YTL05860
        STO     BNULL           B IS NULL                                YTL05870
 MMMA   CLA 0                   LOC MA                                   YTL05880
        STO MA                                                           YTL05890
 MMNA   CLA     0               LOC NA                                   YTL05900
        STO NA                                                           YTL05910
 MMMB   CLA 0                   LOC MB                                   YTL05920
        STO MB                                                           YTL05930
        CLA 0                   LOC NB                                   YTL05940
        STO NB                                                           YTL05950
 MMMT   CLA 5,4                                                          YTL05960
```

```
       PAX 0,1                 CODE                                    YTL05970
       TMI     *+3                                                     YTL05980
       SUB     HIPROG          FIELD 5 MUST BE POSTIVE AND             YTL05990
       TMI     *+3             LESS THAN 32500                         YTL06000
       CLA     =20                                                     YTL06010
       TRA     MMME                                                    YTL06020
       TXH     MACRO,1,33                                              YTL06030
       TRA     LYST,1                                                  YTL06040
       TRA     MMM33                                                   YTL06050
       TRA     MMM32                                                   YTL06060
       TRA     MMM31                                                   YTL06070
       TRA     MMM30                                                   YTL06080
       TRA     MMM29                                                   YTL06090
       TRA     MMM28                                                   YTL06100
       TRA     MMM27                                                   YTL06110
       TRA     MMM26                                                   YTL06120
       TRA     MMM25                                                   YTL06130
       TRA     MMM24                                                   YTL06140
       TRA     MMM23A                                                  YTL06150
       TRA MMM22                                                       YTL06160
       TRA MMM21                                                       YTL06170
       TRA MMM20                                                       YTL06180
       TRA MMM19                                                       YTL06190
       TRA MMM18                                                       YTL06200
       TRA MMM17                                                       YTL06210
       TRA MMM16                                                       YTL06220
       TRA MMM15                                                       YTL06230
       TRA MMM14                                                       YTL06240
       TRA MMM13                                                       YTL06250
       TRA MMM12                                                       YTL06260
       TRA MMM11                                                       YTL06270
       TRA MMM10                                                       YTL06280
       TRA MMM9                                                        YTL06290
       TRA MMM8                                                        YTL06300
       TRA MMM7                                                        YTL06310
       TRA MMM6                                                        YTL06320
       TRA MMM5                                                        YTL06330
       TRA MMM4                                                        YTL06340
       TRA MMM3                                                        YTL06350
       TRA MMM2                                                        YTL06360
       TRA MMM1                                                        YTL06370
 LYST  TRA     MMM0                                                    YTL06380
*                                                                      YTL06390
*                                                                      YTL06400
MACRO  TXH     *+3,1,TSTMAC                                            YTL06410
       CLA     =20             FIELD 5 MUST BE GTE 8000                YTL06420
       TRA     MMME                                                    YTL06430
       PXA     0,1                                                     YTL06440
       ADD     YSHIFT                                                  YTL06450
       STO     YMOP                                                    YTL06460
       ADD     =3                                                      YTL06470
       STO     INST                                                    YTL06480
       STA     SEPD+3                                                  YTL06490
       SUB     =1                                                      YTL06500
       STO     TEMP-1                                                  YTL06510
       STA     *+1                                                     YTL06520
       CLA     **              N                                       YTL06530
       SUB     =6                                                      YTL06540
       TZE     *+3                                                     YTL06550
       CLA     =6              MUST HAVE N=6                           YTL06560
```

```
          TRA     MMME                                                   YTL06570
          CAL     TEMP-1                                                 YTL06580
          SUB     =1                                                     YTL06590
          STA     NOINST                                                 YTL06600
          CLA     KEY                                                    YTL06610
          STA     SAVKEY                                                 YTL06620
          TNZ     *+4               CORE PROGRAM                         YTL06630
          CLA     YMOP                                                   YTL06640
          STO     KEY                                                    YTL06650
          TRA     SEPF                                                   YTL06660
          CLA     YMOP                                                   YTL06670
          STO     KEY                                                    YTL06680
          CLA     INSCNT                                                 YTL06690
          ADD     =1                                                     YTL06700
          STO     INSCNT                                                 YTL06710
 SUBLNK   CLA     MCROCT                                                 YTL06720
          CAS     =5                CHECK FOR FULL RETURN BUFFER         YTL06730
          TRA     *+3                                                    YTL06740
          TRA     *+2                                                    YTL06750
          TRA     NOTFUL                                                 YTL06760
          LXA     =4,1                                                   YTL06770
          CLA     PRGLOC+5,1                                             YTL06780
          STO     PRGLOC+4,1                                             YTL06790
          CLA     RETURN+5,1        MOVE RETURN+1 THRU RETURN+4          YTL06800
          STO     RETURN+4,1        INTO RETURN THRU RETURN+3            YTL06810
          TIX     *-4,1,1                                                YTL06820
          LAC     MCROCT,1                                               YTL06830
          TRA     *+5                                                    YTL06840
 NOTFUL   CAL     MCROCT                                                 YTL06850
          ADD     =1                                                     YTL06860
          SLW     MCROCT                                                 YTL06870
          PAC     0,1                                                    YTL06880
          CAL     SAVINS                                                 YTL06890
          SLW     RETURN-1,1                                             YTL06900
          CAL     XMODE                                                  YTL06910
          ALS     18                                                     YTL06920
          STD     RETURN-1,1                                             YTL06930
          CLA     SAVKEY                                                 YTL06940
          SLW     PRGLOC-1,1                                             YTL06950
          CLA     INSCNT                                                 YTL06960
          ALS     18                                                     YTL06970
          STD     PRGLOC-1,1                                             YTL06980
          TRA     SEPF                                                   YTL06990
*                                                                        YTL07000
*                                                                        YTL07010
  MMME    STO     ERRCDE            SAVE ERROR CODE                      YTL07020
          LXD SPOT4,4                                                    YTL07030
          TRA 6,4                                                        YTL07040
 MMMR     TSX     TAST,4                                                 YTL07050
          LXD SPOT4,4                                                    YTL07060
          CLA 4,4                                                        YTL07070
  LOCC    STO 0                     LOC C                                YTL07080
          CLA MC                                                         YTL07090
 LOCMC    STO 0                     LOC MC                               YTL07100
          CLA NC                                                         YTL07110
 LOCNC    STO 0                     LOC NC                               YTL07120
          TRA 7,4                                                        YTL07130
*                                                                        YTL07140
  TAST    ZET     SIGN                                                   YTL07150
          TTR     TEST2                                                  YTL07160
```

```
       CLA     =0077777000000                                            YTL07170
       STO     SIGN                                                      YTL07180
       CLA     HICORE                                                    YTL07190
       ADD     =1                                                        YTL07200
       STA     *+2                                                       YTL07210
       CLA     COREND                                                    YTL07220
       STO     **                                                        YTL07230
       TTR     1,4                                                       YTL07240
TEST2  CLA*    TEST2-2                                                   YTL07250
       SUB     COREND                                                    YTL07260
       TZE     TEST2-1                                                   YTL07270
       CLA     =19             CORE LIMIT EXCEEDED                       YTL07280
       TRA     MMME                                                      YTL07290
       REM                                                               YTL07300
       REM PACKAGE 1      MMMO,1,2                                       YTL07310
       REM MATRIX TRANSFER, MATRIX ADD, MATRIX SUBTRACT                  YTL07320
       REM                                                               YTL07330
MMMO   CAL     2,4                                                       YTL07340
       TNZ POSIT                                                         YTL07350
       CLA 3,4                                                           YTL07360
       SUB     SMLTAP                                                    YTL07370
       TPL RITE                                                          YTL07380
       CLA 1,4                                                           YTL07390
       SUB     SMLTAP                                                    YTL07400
       TPL REDE                                                          YTL07410
       TRA MOVE                                                          YTL07420
*                                                                        YTL07430
  RITE NZT     MA                                                        YTL07440
       TRA     *+5                                                       YTL07450
       NZT     NA                                                        YTL07460
       TRA     *+3                                                       YTL07470
       TSX     CKDM1,4                                                   YTL07480
       LXD     SPOT4,4                                                   YTL07490
       CLA*    1,4                                                       YTL07500
       TNZ     *+2                                                       YTL07510
       CLA     =0                                                        YTL07520
       STO     SAVE            NAME                                      YTL07530
       CLA     MA                                                        YTL07540
       STO     SAVE+1          M                                         YTL07550
       CLA     NA                                                        YTL07560
       STO     SAVE+2          N                                         YTL07570
       STZ     TESTC                                                     YTL07580
*      SPMTC1=0 IF MATRIX IS NOT SPARSE,OTHERWISE,SPARSE                 YTL07590
       STZ     SPMTC1                                                    YTL07600
       STZ     SAVE+4                                                    YTL07610
       LDQ     MA                                                        YTL07620
       MPY     NA                                                        YTL07630
       XCA                                                               YTL07640
       PAX     0,2             M * N                                     YTL07650
       STO     MTN             SAVE M*N                                  YTL07660
       TNZ     NZRO                                                      YTL07670
       CAL     SAVE                                                      YTL07680
       ACL     SAVE+1                                                    YTL07690
       ACL     SAVE+2                                                    YTL07700
       SLW     SAVE+3                                                    YTL07710
       TRA     WID                                                       YTL07720
  NZRO ADD     =3                                                        YTL07730
       PAX     0,1             M * N + 3                                 YTL07740
       ADD     1,4             A(1,1) + M * N                            YTL07750
       STA     GTCSM                                                     YTL07760
       STA    WRMAT                                            YTL07770
       SXA    MNP3,1                                           YTL07780
CKNUL1 CLA*   WRMAT           TEST FOR WORD M=NULL             YTL07790
       SUB    WDMNL                                            YTL07800
       TZE    NULLM           WORD M=NULL PRESENT              YTL07810
CKNUL2 ZET*   WRMAT           TEST FOR ALL ZEROS               YTL07820
       TRA    GETCKS          NON-ZERO ELEMENT                 YTL07830
       TIX    *-2,2,1                                          YTL07840
NULLM  CAL    WDMNL           FORM CHECK SUM FOR NULL MATRIX   YTL07850
       ACL    SAVE                                             YTL07860
       ACL    SAVE+1                                           YTL07870
       ACL    SAVE+2                                           YTL07880
       SLW    TESTC                                            YTL07890
       TRA    STCKS                                            YTL07900
*             THE FOLLOWING SET OF INSTRUCTIONS                YTL07910
*             DETERMINE IF A MATRIX IS SPARSE. IF              YTL07920
*             THE MATRIX IS SPARSE, THE CHECKSUM IS            YTL07930
*             CALCULATED NEGLECTING NEGATIVE ZEROS.            YTL07940
*             THE CONTROL WORDS ARE FORMED AND PLACED          YTL07950
*             IN THE MATRIX BEFORE THE CHECKSUM IS             YTL07960
*             FORMED. AFTER THE MATRIX IS WRITTEN              YTL07970
*             ON TAPE, THE CONTROL WORDS WILL BE               YTL07980
*             REMOVED FROM THE MATRIX.                         YTL07990
GETCKS LXA    MTN,2                                            YTL08000
CKSP1  CLA*   WRMAT           TEST FOR SPARSE MATRIX           YTL08010
       TZE    *+3                                              YTL08020
       ANA    =0377400000000                                   YTL08030
       TZE    LDCKS           MATRIX NOT SPARSE                YTL08040
       TIX    *-4,2,1                                          YTL08050
       LXA    MTN,2                                            YTL08060
       SXA    SPMTC1,2                                         YTL08070
*                                                              YTL08080
*             THE FOLLOWING FORMS THE CONTROL WORDS            YTL08090
       AXT    0,1             FIX CONTROL WORD                 YTL08100
SPTST1 CLA*   WRMAT                                            YTL08110
       TNZ    SPTST2-1                                         YTL08120
       TXI    *+1,1,1         ADD 1 TO ZERO COUNT              YTL08130
       TIX    SPTST1,2,1                                       YTL08140
       PXA    0,1                                              YTL08150
       STO*   WRMAT           STORE CONTROL WO-D               YTL08160
       TRA    SPCKS           GO FORM CHECKSUM                 YTL08170
       TXH    SPTST2+2,1,0                                     YTL08180
SPTST2 TIX    SPTST1,2,1                                       YTL08190
       TRA    SPCKS           GO FORM CHECKSUM                 YTL08200
       TXI    *+1,2,1                                          YTL08210
       PXA    0,1                                              YTL08220
       STO*   WRMAT           STORE CONTROL WORD               YTL08230
       TIX    SPTST1-1,2,2                                     YTL08240
*                                                              YTL08250
SPCKS  PXA    0,0             FORM SPARSE MATRIX CK SUM        YTL08260
       LXA    MNP3,1                                           YTL08270
CKSP2  ZET*   GTCSM                                            YTL08280
CKSP3  ACL*   GTCSM                                            YTL08290
       TIX    *-2,1,1                                          YTL08300
       ACL    SPARSE                                           YTL08310
       LDQ    SPARSE                                           YTL08320
       STQ    SAVE+4                                           YTL08330
       TRA    STCKS                                            YTL08340
*                                                              YTL08350
LDCKS  PXA    0,0                                              YTL08360
```

```
 GTCSM ACL      **,1                                        YTL08370
       TIX      *-1,1,1                                     YTL08380
 STCKS SLW      SAVE+3        CHECKSUM IN FOURTH WORD       YTL08390
       LXA      MTN,2                                       YTL08400
   WID CLA      3,4                                         YTL08410
       SSP                                                  YTL08420
       TSX      TP,4          GET TAPE NUMBER               YTL08430
       STO      TAPE                                        YTL08440
       TSX      TPCK,4                                      YTL08450
       CALL     .FVIO.(TAPE,TAPEIB)                         YTL08460
       CALL     .FWRB.(TAPEIB)                              YTL08470
       CALL     .FBLO.(SAVE,=16)                            YTL08480
       CALL     .FWLR.                                      YTL08490
       CALL     .FWRB.(TAPEIB)                              YTL08500
       NZT      MTN                                         YTL08510
       TRA      MINR                                        YTL08520
       ZET      SPMTC1                                      YTL08530
       TRA      WRSPRS        SPARSE MATRIX                 YTL08540
       ZET      TESTC                                       YTL08550
       TRA      WRNULL        NULL MATRIX                   YTL08560
WRMAT  CLA      **,2          WRITE MATRIX                  YTL08570
       TSX      .FBLT.,4                                    YTL08580
       TIX      *-2,2,1                                     YTL08590
  MINR CLA      =16                                         YTL08600
       SUB      MTN                                         YTL08610
 WRMR  TMI      ENDWR                                       YTL08620
       TZE      ENDWR                                       YTL08630
       PAX      0,2           M*N LESS THAN 16. WRITE MORE  YTL08640
       ZAC                                                  YTL08650
       TSX      .FBLT.,4                                    YTL08660
       TIX      *-2,2,1                                     YTL08670
       TRA      ENDWR                                       YTL08680
*               WRITE SPARSE MATRIX                         YTL08690
WRSPRS AXT      0,1                                         YTL08700
       CLA*     WRMAT                                       YTL08710
       TZE      SPSZP1        ZERO ELEMENT, DO NOT WRITE    YTL08720
       TSX      .FBLT.,4                                    YTL08730
       TXI      *+1,1,1                                     YTL08740
       LDQ*     WRMAT                                       YTL08750
       PXA      0,0                                         YTL08760
       LLS      9                                           YTL08770
       TNZ      *+2                                         YTL08780
  SPSZ STZ*     WRMAT         STORE ZERO OVER CONTROL WORD  YTL08790
SPSZP1 TIX      WRSPRS+1,2,1                                YTL08800
       SXA      WDWC,1                                      YTL08810
       CLA      =16                                         YTL08820
       SUB      WDWC                                        YTL08830
       TRA      WRMR                                        YTL08840
WRNULL CLA      WDMNL         M=NULL                        YTL08850
       TSX      .FBLT.,4                                    YTL08860
       AXT      15,2                                        YTL08870
       ZAC                                                  YTL08880
       TSX      .FBLT.,4                                    YTL08890
       TIX      *-2,2,1                                     YTL08900
ENDWR  CALL     .FWLR.                                      YTL08910
       TRA      DONE                                        YTL08920
  REDE CLA      1,4                                         YTL08930
       TSX      TP,4          GET TAPE NUMBER               YTL08940
       STO      TAPE                                        YTL08950
       TSX      TPCK,4                                      YTL08960
```

```
        CALL    .FVIO.(TAPE,TAPEIB)                                       YTL08970
        CALL    .FRDB.(TAPEIB)                                            YTL08980
        CALL    .FBLI.(SAVE,=16)                                          YTL08990
        CALL    .FRLR.                                                    YTL09000
        LXD     SPOT4,4                                                   YTL09010
        CLA     SAVE           NAME                                       YTL09020
        STO*    3,4                                                       YTL09030
        NZT     4,4            IS CARD NAME =0                            YTL09040
        TRA     *+5            YES                                        YTL09050
        SUB     4,4            NO                                         YTL09060
        TZE     *+3                                                       YTL09070
        CLA     =17            NAME ON TAPE DOES NOT CHECK                YTL09080
        TRA     MMME                                                      YTL09090
        CLA     SAVE+1         YES                                        YTL09100
        STO*    LOCMC                                                     YTL09110
        STO     MC                                                        YTL09120
        LDQ     SAVE+2                                                    YTL09130
        STQ     NC                                                        YTL09140
        STQ*    LOCNC                                                     YTL09150
        MPY     SAVE+1                                                    YTL09160
        TNZ     DIMOK-2                                                   YTL09170
        XCA                                                               YTL09180
        PAX     0,1            M * N                                      YTL09190
        STO     MTN                                                       YTL09200
        TZE     DIMOK                                                     YTL09210
        TMI     *+2                                                       YTL09220
        CAS     MXDATA                                                    YTL09230
        TRA     *+3                                                       YTL09240
        TRA     DIMOK                                                     YTL09250
        TRA     DIMOK                                                     YTL09260
        CLA     =28                                                       YTL09270
        TRA     MMME                                                      YTL09280
 DIMOK  ADD     =3                                                        YTL09290
        PAX     0,2            M * N + 3                                  YTL09300
        ADD     3,4            A(1,1) + M * N                             YTL09310
        STA     RDMAT                                                     YTL09320
        STA     GTCSM1                                                    YTL09330
        STA     FIXNM                                                     YTL09340
        TSX     CHKCOR,4                                                  YTL09350
RZM     CALL    .FRDB.(TAPEIB)                                            YTL09360
        CLA     SAVE+4                                                    YTL09370
        SUB     SPARSE                                                    YTL09380
        TNZ     CKNUL3                                                    YTL09390
        STZ     RSCKSM         SPARSE MATRIX CHECKSUM                     YTL09400
*                                                                         YTL09410
*       THE FOLLOWING SET OF INSTRUCTIONS READ A                          YTL09420
*       SPARSE MATRIX AND FORMS ITS CHECKSUM                              YTL09430
*                                                                         YTL09440
SPRD    TSX     .FBLT.,4                                                  YTL09450
        STO     READTP         SAVE WORD FROM TAPE                        YTL09460
        CAL     READTP                                                    YTL09470
        ACL     RSCKSM         ADD TO CHECKSUM                            YTL09480
        SLW     RSCKSM                                                    YTL09490
        CAL     READTP                                                    YTL09500
        ANA     =0377400000000                                            YTL09510
        TZE     KCW            CONTROL WORD                               YTL09520
        CLA     READTP                                                    YTL09530
        STO*    RDMAT                                                     YTL09540
        TIX     SPRD,1,1                                                  YTL09550
RLR1    CALL    .FRLR.                                                    YTL09560
```

```
       CAL     RSCKSM            FORM CHECKSUM                           YTL09570
       ACL     SPARSE                                                    YTL09580
       ACL     SAVE                                                      YTL09590
       ACL     SAVE+1                                                    YTL09600
       ACL     SAVE+2                                                    YTL09610
       TRA     RDCKS                                                     YTL09620
 KCW   LXA     READTP,2          STORE ZEROS                             YTL09630
       STZ*    RDMAT                                                     YTL09640
       TXI     *+1,1,-1                                                  YTL09650
       TIX     *-2,2,1                                                   YTL09660
       TXL     RLR1,1,0                                                  YTL09670
       TRA     SPRD                                                      YTL09680
CKNUL3 TSX     .FBLT.,4                                                  YTL09690
       NZT     MTN                                                       YTL09700
       TRA     RDMAT+2                                                   YTL09710
       STO     TESTC                                                     YTL09720
       SUB     WDMNL             M=NULL                                  YTL09730
       TNZ     RDMAT-3                                                   YTL09740
       CALL    .FRLR.                                                    YTL09750
       TRA     NULLMR            MATRIX IS NULL                          YTL09760
*                                                                        YTL09770
       CLA     TESTC             GET A(1,1) BACK                         YTL09780
       TRA     *+2                                                       YTL09790
       TSX     .FBLT.,4                                                  YTL09800
 RDMAT STO     **,1              READ IN MATRIX                          YTL09810
       TIX     *-2,1,1                                                   YTL09820
       CALL    .FRLR.                                                    YTL09830
       CAL     SAVE+3            IS CHECKSUM = 0                         YTL09840
       TZE     DONE              YES, DONE                               YTL09850
       ERA     =1.0              IS CHECKSUM = 1.0                       YTL09860
       TZE     DONE              YES, DONE                               YTL09870
       PXA     0,0               NO, COMPARE CHECKSUMS                   YTL09880
GTCSM1 ACL     **,2                                                      YTL09890
       TIX     *-1,2,1                                                   YTL09900
 RDCKS ERA     SAVE+3                                                    YTL09910
       TZE     DONE                                                      YTL09920
       CLA     =18               CHECKSUM ERROR                          YTL09930
       TRA     MMME                                                      YTL09940
NULLMR LXA     MTN,2             STORE ZEROS FOR NULL MATRIX             YTL09950
 FIXNM STZ     **,2                                                      YTL09960
       TIX     *-1,2,1                                                   YTL09970
       CAL     WDMNL                                                     YTL09980
       SLW*    LC11                                                      YTL09990
       ACL     SAVE              FORM NULL CHECKSUM                      YTL10000
       ACL     SAVE+1                                                    YTL10010
       ACL     SAVE+2                                                    YTL10020
       TRA     RDCKS                                                     YTL10030
 POSIT STZ     TAPE+2                                                    YTL10040
       STP     TAPE+2            SAVE SIGN OF TAPE INSTRUCTION           YTL10050
       CLA     2,4                                                       YTL10060
       SSP                                                               YTL10070
       TSX     TP,4              GET TAPE NO. IN DECREMENT               YTL10080
       STO     TAPE                                                      YTL10090
       STQ     TAPE+1            FILE IN ADDRESS, MATRICES IN DEC.       YTL10100
       TSX     TPCK,4                                                    YTL10110
       CALL    .FVIO.(TAPE,TAPEIB)                                       YTL10120
       CLA     TAPE+1                                                    YTL10130
       TNZ     SPACE1            IS TAPE POSITIONING REQUESTED           YTL10140
       CLA     TAPE+2                                                    YTL10150
       TPL     EOF                                                       YTL10160
```

```
        CALL    .FRWT.(TAPEIB)                     REWIND              YTL10170
        TTR     DONE                                                   YTL10180
EOF     CALL    .FEFT.(TAPEIB)                     WRITE END OF FILE   YTL10190
        TTR     DONE                                                   YTL10200
SPACE1  CLA     TAPE+2                                                 YTL10210
        TPL     FST              FORWARD SPACING                       YTL10220
        CAL     TAPE+1                                                 YTL10230
        ANA     =0000000077777   LEAVE ONLY FILE COUNT                 YTL10240
        SUB     =1                                                     YTL10250
        SLW     TAPE+1                                                 YTL10260
        CALL    BSF(TAPE+1,TAPE,ERR)                                   YTL10270
        CLA     ERR                                                    YTL10280
        TZE     DONE                                                   YTL10290
        ADD     THOUSN                                                 YTL10300
        TRA     MMME                                                   YTL10310
  FST   CAL     TAPE+1                                                 YTL10320
        ANA     =0000000077777                                         YTL10330
        TZE     RCDOLY           NO FILE SPACING                       YTL10340
        SLW     TAPE+2                                                 YTL10350
        CALL    FSF(TAPE+2,TAPE,ERR)                                   YTL10360
        CLA     ERR                                                    YTL10370
        TZE     *+3                                                    YTL10380
        ADD     =2000            FSF ERROR                             YTL10390
        TRA     MMME                                                   YTL10400
        CAL     TAPE+1                                                 YTL10410
        ANA     =0077777000000                                         YTL10420
        TZE     DONE             FILE SPACE ONLY                       YTL10430
        SLW     TAPE+1                                                 YTL10440
RCDOLY  CLA     TAPE+1                                                 YTL10450
        ARS     18                                                     YTL10460
        STO     TAPE+1                                                 YTL10470
        CALL    FSR(TAPE+1,TAPE,ERR)                                   YTL10480
        CLA     ERR                                                    YTL10490
        TZE     DONE                                                   YTL10500
        ADD     =3000            FSR ERROR                             YTL10510
        TRA     MMME                                                   YTL10520
*                                                                      YTL10530
  DONE  TSX     TAST,4                                                 YTL10540
        LXD SPOT4,4                                                    YTL10550
        TRA 7,4                                                        YTL10560
*                                                                      YTL10570
*               INTERPRET TAPE NUMBER                                  YTL10580
*                                                                      YTL10590
 TP     SXD     TEMP,1           SAVE INDEX                            YTL10600
        AXT     0,1                                                    YTL10610
        SUB     SMLTAP                                                 YTL10620
        TMI     TP2              TRANSFER IF BST OR FST                YTL10630
        TXI     *+1,1,1          COUNTER                               YTL10640
        TNZ     *-3                                                    YTL10650
        LDQ     =0               CLEAR MQ IFONLY A TAPE NUMBER         YTL10660
        PXA     0,1              TAPE NUMBER IN AC(ADDRESS)            YTL10670
 TP1    LXD     TEMP,1           LOAD INDEX                            YTL10680
        TTR     1,4              RETURN                                YTL10690
 TP2    STZ     TEMP-1                                                 YTL10700
        SXA     TEMP-1,1         SAVE TAPE NUMBER                      YTL10710
        ADD     MILYN                                                  YTL10720
        AXT     0,1                                                    YTL10730
        SUB     THOUSN                                                 YTL10740
        TMI     TP4              TRANSFER IF FST                       YTL10750
        TXI     *+1,1,1          COUNTER                               YTL10760
```

```
       TNZ     *-3                                                      YTL10770
       PXD     0,0           CLEAR MQ AND AC                            YTL10780
       XCA                                                              YTL10790
       PXA     0,1            NO. OF FILES IN AC(ADDRESS)               YTL10800
       XCA                       NOW IN MQ                              YTL10810
TP3    CLA     TEMP-1         TAPE NUMBER                               YTL10820
       TTR     TP1                                                      YTL10830
TP4    STZ     TEMP-2                                                   YTL10840
       SXA     TEMP-2,1       SAVE NO. OF FILES                         YTL10850
       ADD     THOUSN                                                   YTL10860
       ALS     19             2*NO. OF RECDS IN DECREMENT               YTL10870
       STD     TEMP-2                                                   YTL10880
       LDQ     TEMP-2         FILES IN ADDR, RECDS IN DECRE.            YTL10890
       TTR     TP3                                                      YTL10900
*                                                                       YTL10910
*              CHECK TAPE NUMBER                                        YTL10920
*                                                                       YTL10930
TPCK   LXA     TAPE,1                                                   YTL10940
       TXL     *+3,1,MXTAPS                                             YTL10950
       CLA     =13                                                      YTL10960
       TRA     MMME                                                     YTL10970
       TTR     TPCK0,1                                                  YTL10980
TPCK19 TTR     1,4                                                      YTL10990
TPCK18 TTR     1,4                                                      YTL11000
TPCK17 TTR     1,4                                                      YTL11010
TPCK16 TTR     1,4                                                      YTL11020
TPCK15 TTR     1,4                                                      YTL11030
TPCK14 TTR     1,4                                                      YTL11040
TPCK13 TTR     1,4                                                      YTL11050
TPCK12 TTR     1,4                                                      YTL11060
TPCK11 TTR     1,4                                                      YTL11070
TPCK10 TTR     1,4                                                      YTL11080
TPCK9  TTR     1,4                                                      YTL11090
 TPCK8 TTR     1,4                                                      YTL11100
 TPCK7 TTR     MMMTP          STACKED PUNCH OUTPUT                      YTL11110
 TPCK6 TTR     MMMTP          STACKED OUTPUT                            YTL11120
 TPCK5 TTR     MMMTP          STACKED INPUT ONLY                        YTL11130
 TPCK4 TTR     1,4                                                      YTL11140
 TPCK3 TTR     1,4                                                      YTL11150
 TPCK2 TTR     1,4                                                      YTL11160
 TPCK1 TTR     1,4                                                      YTL11170
 TPCK0 TRA     TPCK+2                                                   YTL11180
 MMMTP CLA     =14            LEGAL TAPE, BUT NOT ACCESSIBLE            YTL11190
       TRA     MMME                                                     YTL11200
*                                                                       YTL11210
*              THIS ROUTINE CHECKS THE LEGALITY OF                      YTL11220
*              DIMENSIONS OF FIELD 1 OR 2, OR BOTH                      YTL11230
*              M * N MUST BE LESS THAN 24561 , NON-ZERO, AND POSITIVE   YTL11240
*                                                                       YTL11250
 CKDM1 LDQ     MA             FIELD 1 CHECK                             YTL11260
       MPY     NA                                                       YTL11270
       TNZ     BADDM1                                                   YTL11280
       XCA                                                              YTL11290
       TZE     BADDM1                                                   YTL11300
       TMI     BADDM1                                                   YTL11310
       CAS     MXDATA                                                   YTL11320
       TRA     BADDM1                                                   YTL11330
       TRA     1,4                                                      YTL11340
       TRA     1,4                                                      YTL11350
 CKDM2 LDQ     MB             FIELD 2 CHECK                             YTL11360
```

```
        MPY     NB                                                      YTL11370
        TNZ     BADDM2                                                  YTL11380
        XCA                                                             YTL11390
        TZE     BADDM2                                                  YTL11400
        TMI     BADDM2                                                  YTL11410
        CAS     MXDATA                                                  YTL11420
        TRA     BADDM2                                                  YTL11430
        TRA     1,4                                                     YTL11440
        TRA     1,4                                                     YTL11450
CKDM12  SXA     CKDMRT,4        CHECK BOTH FIELDS                       YTL11460
        TSX     CKDM1,4                                                 YTL11470
        TSX     CKDM2,4                                                 YTL11480
CKDMRT  AXT     **,4                                                    YTL11490
        TRA     1,4                                                     YTL11500
BADDM1  CLA     =3                                                      YTL11510
        TRA     MMME                                                    YTL11520
BADDM2  CLA     =4                                                      YTL11530
        TRA     MMME                                                    YTL11540
*                                                                       YTL11550
*               CHECK TO SEE IF A DIAGONAL MATRIX                       YTL11560
*               IS A 1 X N OR A M X 1                                   YTL11570
*                                                                       YTL11580
 CKDG1  CLA     =1                                                      YTL11590
        CAS     MA                                                      YTL11600
        TRA     BADDM1                                                  YTL11610
        TRA     1,4                                                     YTL11620
        CAS     NA                                                      YTL11630
        TRA     BADDM1                                                  YTL11640
        TRA     1,4                                                     YTL11650
 NOTDG  CLA     =5                                                      YTL11660
        TRA     MMME                                                    YTL11670
 CKDG2  CLA     =1                                                      YTL11680
        CAS     MB                                                      YTL11690
        TRA     BADDM2                                                  YTL11700
        TRA     1,4                                                     YTL11710
        CAS     NB                                                      YTL11720
        TRA     BADDM2                                                  YTL11730
        TRA     1,4                                                     YTL11740
        TRA     NOTDG                                                   YTL11750
*               CHECK TO SEE IF RESULT MATRIX WILL OVERFLOW CORE        YTL11760
CHKCOR  LDQ     MC                                                      YTL11770
        MPY     NC                                                      YTL11780
        XCA                                                             YTL11790
        ADD     LC11                                                    YTL11800
        CAS     HICORE                                                  YTL11810
        TRA     OVER                                                    YTL11820
        TRA     1,4                                                     YTL11830
        TRA     1,4                                                     YTL11840
  OVER  CLA     =19                                                     YTL11850
        TRA     MMME                                                    YTL11860
*               CHECK TO SEE IF AN ADDRESS IS BETWEEN                   YTL11870
*               8000 AND 32563,INCLUSIVE                                YTL11880
CHKRNG  CAS     HICORE          THE RETURN IS MADE AS                   YTL11890
        TRA     1,4             WITH A CAS INSTRUCTION                  YTL11900
        TRA     2,4             ABOVE - 1,4                             YTL11910
        CAS     LOCORE          INBETWEEN - 2,4                         YTL11920
        TRA     2,4             BELOW - 3,4                             YTL11930
        TRA     2,4                                                     YTL11940
        TRA     3,4                                                     YTL11950
*                                                                       YTL11960
*               FLOATING POINT TRAP ANALYSIS FOR ALL                    YTL11970
*               OF THE OPERATION CODES                                  YTL11980
*                                                                       YTL11990
FPSPIL STO      TEMPAC                                                  YTL12000
       STQ      TEMPMQ                                                  YTL12010
       CLA      0                                                       YTL12020
       STD      CELLO                                                   YTL12030
       CLA      CELLO                                                   YTL12040
       CAS      =3B17                                                   YTL12050
       TRA      TSTDIV          NOT UNDERFLOW FROM MPY, ADD             YTL12060
       TRA      ACMQUF          UNDERFLOW IN BOTH AC AND MQ             YTL12070
       CLA      TEMPAC          UNDERFLOW IN MQ ONLY                    YTL12080
       LDQ      =0                                                      YTL12090
       STZ      CELLO           CLEAR CELL IF UNDERFLOW                 YTL12100
       TRA*     0                                                       YTL12110
ACMQUF PXA      0,0             CLEAR AC                                YTL12120
       TRA      *-4                                                     YTL12130
TSTDIV CAS      =9B17                                                   YTL12140
       TRA      *+4             IT IS A DIVIDE, TEST FURTHER            YTL12150
       TRA      ACMQUF          MQ UNDERFLOW ON DIVIDE                  YTL12160
       CLA      =8              OVERFLOW ON MPY OR ADD                  YTL12170
       TRA      MMME                                                    YTL12180
       CAS      =11B17                                                  YTL12190
       TRA      POSSTO          OVERFLOW ON DIVIDE OR IT                YTL12200
*                               COULD ALSO BE DOUBLE PRECISION          YTL12210
*                               STORAGE TRAP                            YTL12220
       TRA      ACMQUF          AC,MQ UNDERFLOW ON DIVIDE               YTL12230
       PXA      0,0             AC UNDERFLOW ONLY                       YTL12240
       LDQ      TEMPMQ                                                  YTL12250
       TRA      ACMQUF-2                                                YTL12260
POSSTO CAS      =13B17                                                  YTL12270
       TRA      *+4                                                     YTL12280
       TRA      *+1                                                     YTL12290
       CLA      =9                                                      YTL12300
       TRA      MMME            DIVIDE OVERFLOW                         YTL12310
       CLA      =27                                                     YTL12320
       TRA      MMME            D.P. STORAGE TRAP.                      YTL12330
*               THE FOLLOWING ARE ADDITIONS TO CONSIDER                 YTL12340
*               ADDITION AND MULTIPLICATION OF NULL                     YTL12350
*               MATRICES. MARCH 1963                                    YTL12360
 NADD1 LDQ      FILL5           B IS NULL                               YTL12370
       STQ      LDMT                                                    YTL12380
       STA      STMT                                                    YTL12390
       SUB      LC11                                                    YTL12400
       ADD      LA11                                                    YTL12410
       STA      LDMT                                                    YTL12420
 LDMT                           LA11+MNA                                YTL12430
 STMT  STO      **,1            LC11+MNC                                YTL12440
       TIX      *-2,1,1                                                 YTL12450
       TRA      MMMR                                                    YTL12460
*                               A IS NULL FOR MMM3 OR MMM4              YTL12470
 LDMT1                          LB11+MNB                                YTL12480
 STMT1 STO      **,2            LC11+MNC                                YTL12490
       TIX      STMT1+3,1,0     NB                                      YTL12500
       TXI      STMT1+1,1,0     MN-1                                    YTL12510
       TIX      LDMT1,2,1                                               YTL12520
       TRA      MMMR                                                    YTL12530
*                                                                       YTL12540
 NMPY1 SXA      NLP1,2                                                  YTL12550
       LXA      NLP1,4                                                  YTL12560
```

```
NMPY   STA     NLP1                  NULL MATRIX MULTIPLY                    YTL12570
NLP1   STZ     **,4                                                          YTL12580
       TIX     *-1,4,1                                                       YTL12590
       CLA     WDMNL                                                         YTL12600
       STO*    LC11                                                          YTL12610
       TRA     MMMR                                                          YTL12620
MMMCF  CLA     =1                    NON CONFORMABLE MATRICES.               YTL12630
       TRA     MMME                                                          YTL12640
*                                                                            YTL12650
MOVE   CLA FILL0                                                             YTL12660
       STO STAL1                                                             YTL12670
       LDQ     MA                                                            YTL12680
       MPY     NA                                                            YTL12690
       TNZ     *+3                                                           YTL12700
       XCA                                                                   YTL12710
       TZE     *+2                   ALLOW A MOVE OF 0 X 0, M X 0, 0 X N     YTL12720
       TSX     CKDM1,4               CHECK DIMENSIONS IN FIELD 1             YTL12730
       LDQ MA                                                                YTL12740
       STQ MC                                                                YTL12750
       CLA NA                                                                YTL12760
       STO NC                                                                YTL12770
       TRA ELXEL                                                             YTL12780
MMM1   LDQ     FILL5                 MATRIX ADD                              YTL12790
       CLA     FILL1                                                         YTL12800
       TRA     *+3                                                           YTL12810
MMM2   LDQ     FILL6                 MATRIX SUB                              YTL12820
       CLA     FILL2                                                         YTL12830
       STQ     LDMT                                                          YTL12840
       STO STAL1                                                             YTL12850
       TSX     CKDM12,4              CHECK DIMENSIONS IN FIELDS 1,2          YTL12860
       CLA MA                                                                YTL12870
       STO MC                                                                YTL12880
       SUB MB                                                                YTL12890
       TNZ     MMMCF                 NON-CONFORMABLE                         YTL12900
       CLA NA                                                                YTL12910
       STO NC                                                                YTL12920
       SUB NB                                                                YTL12930
       TNZ     MMMCF                 NON-CONFORMABLE                         YTL12940
ELXEL  LDQ MA                        LOOP CONTROL                            YTL12950
       MPY NA                                                                YTL12960
       XCA                                                                   YTL12970
       PAX 0,1                       MNA,B,C                                 YTL12980
       ADD LA11                                                              YTL12990
       STA ITR81                                                             YTL13000
       SUB LA11                                                              YTL13010
       ADD LB11                                                              YTL13020
       STA STAL1                                                             YTL13030
       STA     LDMT                                                          YTL13040
       SUB LB11                                                              YTL13050
       ADD LC11                                                              YTL13060
       STA     STMT                                                          YTL13070
       STA STAL1+1                                                           YTL13080
       TSX     CHKCOR,4                                                      YTL13090
       LXD     SPOT4,4                                                       YTL13100
       NZT     5,4                                                           YTL13110
       TRA     MOVEUP                                                        YTL13120
       ZET     BNULL                                                         YTL13130
       TRA     NADD1                 B IS NULL                               YTL13140
       ZET     ANULL                                                         YTL13150
       TRA     LDMT                  A IS NULL                               YTL13160
```

```
 ITR81 CLA 0,1               LA11+MNA                                   YTL13170
 STAL1                       LB11+MNB                                   YTL13180
       STO 0,1               LC11+MNC                                   YTL13190
       TIX ITR81,1,1                                                    YTL13200
       TRA MMMR                                                         YTL13210
MOVEUP CLA     3,4                                                      YTL13220
       SUB     1,4                                                      YTL13230
       TMI     ITR81         MOVE DOWN                                  YTL13240
       CLA     ITR81         MOVE UP                                    YTL13250
       STA     MSPOT1                                                   YTL13260
       CLA     STAL1+1                                                  YTL13270
       STA     MSPOT2                                                   YTL13280
       SXD     MSPOT3,1                                                 YTL13290
       AXT     1,1                                                      YTL13300
MSPOT1 CLA     0,1           LA11+MNA                                   YTL13310
MSPOT2 STO     0,1           LC11+MNC                                   YTL13320
       TXI     *+1,1,1                                                  YTL13330
MSPOT3 TXL     MSPOT1,1,**   MNA                                        YTL13340
       TRA     MMMR                                                     YTL13350
       REM PACKAGE 2     MMM3,4                                         YTL13360
       REM ADD AND SUBTRACT TRANSPOSE                                   YTL13370
       REM                                                              YTL13380
 MMM3  LDQ     FILL5         ADD TRANSPOSE                              YTL13390
       CLA     FILL3                                                    YTL13400
       TRA     *+3                                                      YTL13410
 MMM4  LDQ     FILL6         SUB TRANSPOSE                              YTL13420
       CLA     FILL4                                                    YTL13430
       STQ     LDMT1                                                    YTL13440
       STO STAL2                                                        YTL13450
       TSX     CKDM12,4      CHECK DIMENSIONS OF FIELDS 1,2             YTL13460
       CLA MA                                                           YTL13470
       STO MC                                                           YTL13480
       SUB NB                                                           YTL13490
       TNZ     MMMCF         NON-CONFORMABLE                            YTL13500
       CLA NA                                                           YTL13510
       STO NC                                                           YTL13520
       SUB MB                                                           YTL13530
       TNZ     MMMCF         NON-CONFORMABLE                            YTL13540
       TSX     CHKCOR,4                                                 YTL13550
       LDQ MA                LOOP CONTROL                               YTL13560
       MPY NA                                                           YTL13570
       XCA                                                              YTL13580
       PAX     0,1           MNA,MNC                                    YTL13590
       PAX     0,2           MNB                                        YTL13600
       SUB     =1                                                       YTL13610
       ALS 18                                                           YTL13620
       STD     STAL2+3                                                  YTL13630
       STD     STMT1+2                                                  YTL13640
       ARS 18                                                           YTL13650
       ADD     =1                                                       YTL13660
       ADD LA11                                                         YTL13670
       STA ITR82                                                        YTL13680
       SUB LA11                                                         YTL13690
       ADD LB11                                                         YTL13700
       STA STAL2                                                        YTL13710
       STA     LDMT1                                                    YTL13720
       SUB LB11                                                         YTL13730
       ADD LC11                                                         YTL13740
       STA     STMT1                                                    YTL13750
       ZET     BNULL                                                    YTL13760
       TRA     NADD1         B IS NULL                                   YTL13770
       STA STAL2+1                                                       YTL13780
       CLA NB                                                            YTL13790
       ALS 18                                                            YTL13800
       STD     STMT1+1                                                   YTL13810
       ZET     ANULL                                                     YTL13820
       TRA     LDMT1                                                     YTL13830
       STD     STAL2+2                                                   YTL13840
 ITR82 CLA 0,1               LA11+MNA                                    YTL13850
 STAL2                       LB11+MNB                                    YTL13860
       STO 0,1               LC11+MNC                                    YTL13870
       TIX     STAL2+4,2,0   NB                                          YTL13880
       TXI     STAL2+2,2,0   MN-1                                        YTL13890
       TIX ITR82,1,1                                                     YTL13900
       TRA MMMR                                                          YTL13910
       REM                                                               YTL13920
       REM PACKAGE 3  MMM5                                               YTL13930
       REM SCALAR MULTIPLY                                               YTL13940
       REM                                                               YTL13950
  MMM5 TSX     CKDM2,4       CHECK DIMENSIONS IN FIELD 2                 YTL13960
       LDQ     MB                                                        YTL13970
       STQ MC                                                            YTL13980
       CLA NB                                                            YTL13990
       STO NC                                                            YTL14000
       TSX     CHKCOR,4                                                  YTL14010
       LDQ     MB                                                        YTL14020
       MPY NB                                                            YTL14030
       XCA                                                               YTL14040
       PAX 0,1               MNB                                         YTL14050
       ADD LB11                                                          YTL14060
       STA ITR83+1                                                       YTL14070
       SUB LB11                                                          YTL14080
       ADD LC11                                                          YTL14090
       STA ITR83+2                                                       YTL14100
       XCA                                                               YTL14110
       CLA     YMAA                                                      YTL14120
       STA ITR83                                                         YTL14130
       PXA     0,1                                                       YTL14140
       PAX     0,4                                                       YTL14150
       XCA                                                               YTL14160
       ZET     BNULL                                                     YTL14170
       TRA     NMPY          B IS NULL                                   YTL14180
 ITR83 LDQ 0                 LOC A                                       YTL14190
       FMP 0,1               LOC BMN+1                                   YTL14200
       STO 0,1               LOC CMN+1                                   YTL14210
       TIX ITR83,1,1                                                     YTL14220
       TRA MMMR                                                          YTL14230
*                                                                        YTL14240
*              PACKAGE 4,MMM6,MMM7,MMM8                                  YTL14250
*              THESE ARE THE THREE MULTIPLY ROUTINES                     YTL14260
*              WHICH ARE WRITTEN FOR THE 7094                            YTL14270
*              THEY USE COMMON MULTIPLY INSTRUCTIONS                     YTL14280
*              AND A DFAD. INCLUDES A NULL MULTIPLY                      YTL14290
*              ADDED 5/63                                                YTL14300
*                                                                        YTL14310
  MMM6 CLA     NA            MULTIPLY                                    YTL14320
       SUB     MB                                                        YTL14330
       TNZ     MMMCF         CONFORMABILITY CHECK                        YTL14340
       TSX     CKDM12,4      CHECK DIMENSIONS                            YTL14350
       LXA     MA,3          TOTAL ROWS OF A                             YTL14360
```

```
        LXA    NB,4            TOTAL COLUMNS OF B                       YTL14370
        SXA    NC,4            COLUMN DIMENSION OF PRODUCT              YTL14380
        LDQ    MA                                                       YTL14390
        STQ    MC              ROW DIMENSION OF PRODUCT                 YTL14400
        MPY    NB                                                       YTL14410
        XCA                                                             YTL14420
        PAX    0,5             TOTAL NO. OF ELEMENTS IN PRODUCT         YTL14430
        ADD    LC11                                                     YTL14440
        STA    ANSWER          STORAGE OF ANSWER                        YTL14450
        TSX    CHKCOR,4                                                 YTL14460
        LXA    NB,4                                                     YTL14470
        CAL    ANULL           CHECK FOR A OR B NULL                    YTL14480
        ACL    BNULL                                                    YTL14490
        TNZ    ZROMPY                                                   YTL14500
        CLA    NA                                                       YTL14510
        STO    TOTA            NUMBER OF ELEMENTS IN ROW OF A           YTL14520
        STO    INCRMA          STORAGE INCREMENT FROM ROW TO ROW        YTL14530
        ADD    LA11                                                     YTL14540
        STA    ELEMA           ADDRESS FOR A                            YTL14550
        LDQ    MB                                                       YTL14560
        MPY    NB                                                       YTL14570
        XCA                                                             YTL14580
        STO    TOTB            TOTAL NUMBER OF ELEMENTS IN B            YTL14590
        ADD    LB11                                                     YTL14600
        STA    ELEMB           ADDRESS FOR B                            YTL14610
        LXA    =1,1                                                     YTL14620
        SXD    MPTST1,1        DECREMENT FOR A                          YTL14630
        SXA    INCRMB,1        STORAGE INCREMENT FROM COL. TO COL.      YTL14640
        LXA    NB,1                                                     YTL14650
        SXD    MPTST1+1,1      DECREMENT FOR B                          YTL14660
        TRA    MULTPY                                                   YTL14670
*                                                                       YTL14680
*              SET UP CONTROL NUMBERS FOR MMM7                          YTL14690
*                                                                       YTL14700
 MMM7   CLA    NA              POST MULTIPLY BY TRANSPOSE               YTL14710
        SUB    NB                                                       YTL14720
        TNZ    MMMCF           CONFORMABILITY CHECK                     YTL14730
        TSX    CKDM12,4        CHECK DIMENSIONS                         YTL14740
        LXA    MA,3            TOTAL ROWS IN A                          YTL14750
        LXA    MB,4            TOTAL ROWS IN B                          YTL14760
        SXA    NC,4            COLUMN DIMENSION OF PRODUCT              YTL14770
        LDQ    MA                                                       YTL14780
        STQ    MC              ROW DIMENSION OF PRODUCT                 YTL14790
        MPY    MB                                                       YTL14800
        XCA                                                             YTL14810
        PAX    0,5             TOTAL NUMBER OF ELEMENTS IN PRODUCT.     YTL14820
        ADD    LC11                                                     YTL14830
        STA    ANSWER          STORAGE OF ANSWER                        YTL14840
        TSX    CHKCOR,4                                                 YTL14850
        LXA    MB,4                                                     YTL14860
        CAL    ANULL           CHECK FOR A OR B NULL                    YTL14870
        ACL    BNULL                                                    YTL14880
        TNZ    ZROMPY                                                   YTL14890
        CLA    NA                                                       YTL14900
        STO    TOTA            NUMBER OF ELEMENTS IN ROW OF A           YTL14910
        STO    INCRMA          STORAGE INCREMENT FROM ROW TO ROW        YTL14920
        ADD    LA11                                                     YTL14930
        STA    ELEMA           ADDRESS FOR A                            YTL14940
        CLA    NB              NUMBER OF ELEMENTS IN ROW OF B           YTL14950
        STO    TOTB                                                     YTL14960
        STO     INCRMB          STORAGE INCREMENT FROM ROW TO ROW         YTL14970
        ADD     LB11                                                      YTL14980
        STA     ELEMB                                                     YTL14990
        LXA     =1,1                                                      YTL15000
        SXD     MPTST1,1        DECREMENT FOR A                           YTL15010
        SXD     MPTST1+1,1      DECREMENT FOR B                           YTL15020
        TRA     MULTPY                                                    YTL15030
*                                                                         YTL15040
*               SET UP CONTROL NUMBERS FOR MMM8                           YTL15050
*                                                                         YTL15060
MMM8    CLA     MA              PRE MULTIPLY BY TRANSPOSE                 YTL15070
        SUB     MB                                                        YTL15080
        TNZ     MMMCF           CONFORMABILITY CHECK                      YTL15090
        TSX     CKDM12,4        CHECK DIMENSIONS                          YTL15100
        LXA     NA,3            TOTAL COLUMNS OF A                        YTL15110
        SXA     MC,3            ROW DIMENSION OF PRODUCT                  YTL15120
        LXA     NB,4            TOTAL COLUMNS OF B                        YTL15130
        SXA     NC,4            COLUMN DIMENSION OF PRODUCT               YTL15140
        LDQ     NA                                                        YTL15150
        MPY     NB                                                        YTL15160
        XCA                                                               YTL15170
        PAX     0,5             TOTAL NUMBER OF ELEMENTS IN PRODUCT       YTL15180
        ADD     LC11                                                      YTL15190
        STA     ANSWER          STORAGE OF ANSWER                         YTL15200
        TSX     CHKCOR,4                                                  YTL15210
        LXA     NB,4                                                      YTL15220
        CAL     ANULL           CHECK FOR A OR B NULL                     YTL15230
        ACL     BNULL                                                     YTL15240
        TNZ     ZROMPY                                                    YTL15250
        LXA     NA,1                                                      YTL15260
        SXD     MPTST1,1        DECREMENT FOR A                           YTL15270
        LDQ     NA                                                        YTL15280
        MPY     MA                                                        YTL15290
        XCA                                                               YTL15300
        STO     TOTA            TOTAL NUMBER OF ELEMENTS IN A             YTL15310
        ADD     LA11                                                      YTL15320
        STA     ELEMA           ADDRESS FOR A                             YTL15330
        LXA     NB,1                                                      YTL15340
        SXD     MPTST1+1,1      DECREMENT FOR B                           YTL15350
        LDQ     NB                                                        YTL15360
        MPY     MB                                                        YTL15370
        XCA                                                               YTL15380
        STO     TOTB            TOTAL NUMBER OF ELEMENTS IN B             YTL15390
        ADD     LB11                                                      YTL15400
        STA     ELEMB           ADDRESS FOR B                             YTL15410
        CLA     =1                                                        YTL15420
        STO     INCRMA          INCREMENT FOR A                           YTL15430
        STO     INCRMB          INCREMENT FOR B                           YTL15440
        TRA     MULTPY                                                    YTL15450
ZROMPY  CLA     MAD                                                       YTL15460
        STZ     MAD                                                       YTL15470
        TNZ     MMMR                                                      YTL15480
        CAL     WDMNL                                                     YTL15490
        SLW*    LC11                                                      YTL15500
        TNX     MMMR,5,1                                                  YTL15510
        STZ*    ANSWER                                                    YTL15520
        TIX     *-1,5,1                                                   YTL15530
        TRA     MMMR                                                      YTL15540
*                                                                         YTL15550
*               MULTIPLY LOOP USED BY MMM6,7,8                            YTL15560
*                                                                       YTL15570
MULTPY PXA     DOTPRD,0                                                 YTL15580
       CLA     *-1                                                      YTL15590
       LBT                                                              YTL15600
       TRA     *+2                                                      YTL15610
       ADD     =1                                                       YTL15620
       STA     SUMPRD                                                   YTL15630
       CLA     MAD                                                      YTL15640
       TZE     NOADD                                                    YTL15650
       CAL     MADYES        PUT IN ADD FOR MPY AND ADD                 YTL15660
       SLW     ANSWER-2                                                 YTL15670
       STZ     MAD                                                      YTL15680
       TRA     *+3                                                      YTL15690
 NOADD CAL     MADNO         MULTIPLY ONLY,USE DUMMY                    YTL15700
       SLW     ANSWER-2                                                 YTL15710
STRTLP LXA     TOTA,1                                                   YTL15720
       LXA     TOTB,2                                                   YTL15730
       LDQ     =0                                                       YTL15740
       PXA     0,0.                                                     YTL15750
       DST*    SUMPRD        ZERO DOT PRODUCT                           YTL15760
ZROTST NZT*    ELEMA                                                    YTL15770
       TRA     MPTST1                                                   YTL15780
       NZT*    ELEMB                                                    YTL15790
       TRA     MPTST1                                                   YTL15800
 ELEMA LDQ     **,1          ELEMENT OF A                               YTL15810
 ELEMB FMP     **,2          ELEMENT OF B                               YTL15820
SUMPRD DFAD    **            RUNNING PRODUCT                            YTL15830
       DST*    *-1                                                      YTL15840
MPTST1 TIX     *+1,1,**      DECREMENT FOR A                            YTL15850
       TIX     ZROTST,2,**   DECREMENT FOR B                            YTL15860
       HTR     MMMR          VARIABLE CELL FOR OP. CODES 30,31,32       YTL15870
       FRN                                                              YTL15880
ANSWER STO     **,5          STORE DOT PRODUCT                          YTL15890
       TIX     *+1,5,1                                                  YTL15900
       TNX     NEWRCA,4,1    TRA IF A NEW ROW OR COLUMN OF A IS NEEDED  YTL15910
       CLA     ELEMB         GET NEW COLUMN OR ROW OF B.                YTL15920
       ADD     INCRMB                                                   YTL15930
       STA     ELEMB                                                    YTL15940
       TRA     STRTLP        NEXT ELEMENT OF ROW OF PRODUCT             YTL15950
NEWRCA TNX     MMMR,3,1      COUNT OF ROWS OR COLUMNS OF A USED         YTL15960
       LXA     NC,4          RE-SET COUNT OF ROWS OR COLS OF B          YTL15970
       CLA     ELEMA         GET NEW ROW/COLUMN OF A                    YTL15980
       ADD     INCRMA                                                   YTL15990
       STA     ELEMA                                                    YTL16000
       CLA     LB11          START OVER WITH STORAGE ACCESS TO B        YTL16010
       ADD     TOTB                                                     YTL16020
       STA     ELEMB                                                    YTL16030
       TRA     STRTLP                                                   YTL16040
       REM                                                              YTL16050
       REM PACKAGE 5     MMM9                                           YTL16060
       REM MATRIX TRANSPOSE                                             YTL16070
       REM                                                              YTL16080
  MMM9 TSX     CKDM1,4                                                  YTL16090
       CLA     MA                                                       YTL16100
       STO NC                                                           YTL16110
       ALS 18                                                           YTL16120
       STD ITR85+3                                                      YTL16130
       LDQ NA                                                           YTL16140
       STQ MC                                                           YTL16150
       TSX     CHKCOR,4                                                 YTL16160
       LDQ     NA                                                      YTL16170
       MPY MA                                                          YTL16180
       XCA                                                             YTL16190
       PAX     0,1                                                     YTL16200
       PAX     0,4                                                     YTL16210
       ADD LA11                                                        YTL16220
       STA ITR85                                                       YTL16230
       SUB LA11                                                        YTL16240
       ADD LC11                                                        YTL16250
       ZET     ANULL                                                   YTL16260
       TRA     NMPY         A IS NULL                                  YTL16270
       STA ITR85+1                                                     YTL16280
       SUB LC11                                                        YTL16290
       ALS 18                                                          YTL16300
       CHS                                                             YTL16310
       ADD ITR85+3                                                     YTL16320
       COM                                                             YTL16330
       STD ITR85+4                                                     YTL16340
ITR85  CLA 0,1              LA11+MNA                                   YTL16350
       STO 0,4              LC11+MNC                                   YTL16360
       TNX MMMR,1,1                                                    YTL16370
       TIX ITR85,4,0        NC                                         YTL16380
       TXI ITR85,4,0        MNC-NC-1                                   YTL16390
       REM                                                             YTL16400
       REM PACKAGE 6    MMM10,11                                       YTL16410
       REM ADD, SUBTRACT DIAGONAL MATRIX                               YTL16420
       REM                                                             YTL16430
       REM                                                             YTL16440
MMM10  CLA FIL10            ADD DIAGONAL                               YTL16450
       CAS FIL10                                                       YTL16460
MMM11  CLA FIL11            SUB DIAGONAL                               YTL16470
       STO STAL6                                                       YTL16480
       CLA     FILL5        INITIALIZE ITR86 WITH CLA 0,1              YTL16490
       STO     ITR86                                                   YTL16500
       TSX     CKDM12,4     CHECK DIMENSIONS IN FIELDS 1,2             YTL16510
       TSX     CKDG2,4                                                 YTL16520
       CLS     =1           LOOP CONTROL                               YTL16530
       ADD MB                                                          YTL16540
       ADD NB                                                          YTL16550
       SUB MA                                                          YTL16560
       TNZ     MMMCF        NON-CONFORMABLE                            YTL16570
       ADD MA                                                          YTL16580
       ADD LB11                                                        YTL16590
       STA STAL6                                                       YTL16600
       SUB LB11                                                        YTL16610
       ALS 18                                                          YTL16620
       STD     ITR86+3                                                 YTL16630
       ARS 18                                                          YTL16640
       PAX 0,2              NB                                         YTL16650
       SUB NA                                                          YTL16660
       TNZ     MMMCF        NON-CONFORMABLE                            YTL16670
       LDQ MA                                                          YTL16680
       STQ MC                                                          YTL16690
       STQ NC                                                          YTL16700
       TSX     CHKCOR,4                                                YTL16710
       LDQ     MA                                                      YTL16720
       MPY NA                                                          YTL16730
       XCA                                                             YTL16740
       PAX 0,1              MNA                                        YTL16750
       ADD LA11                                                        YTL16760
       STA ITR86                                                        YTL16770
       SUB LA11                                                         YTL16780
       ADD LC11                                                         YTL16790
       STA     ITR86+5                                                  YTL16800
       AXT     1,4                                                      YTL16810
       ZET     BNULL                                                    YTL16820
       TRA     NADD1         B IS NULL                                  YTL16830
       CLA     FILL7                                                    YTL16840
       ZET     ANULL                                                    YTL16850
       STO     ITR86         A IS NULL                                  YTL16860
ITR86  CLA 0,1               LA11+MNA                                   YTL16870
       TIX     ITR86+5,4,1                                              YTL16880
STAL6                        LB11+NB                                    YTL16890
       TXI     ITR86+4,4,0   MA                                         YTL16900
       TNX     ITR86+5,2,1                                              YTL16910
       STO 0,1               LC11+MNC                                   YTL16920
       TIX ITR86,1,1                                                    YTL16930
       TRA MMMR                                                         YTL16940
       REM                                                              YTL16950
       REM PACKAGE 7     MMM12,13,14,15,16                              YTL16960
       REM MULTIPLY MATRIX OR TRANSPOSE PRE OR POST BY DIAGONAL         YTL16970
       REM MULTIPLY DIAGONAL BY DIAGONAL OR TWO MATRICES BY ELEMENT     YTL16980
       REM                                                              YTL16990
       REM PACKAGE 7.1   MMM12                                          YTL17000
       REM POST MULTIPLY BY DIAGONAL                                    YTL17010
MMM12  TSX     CKDM12,4      CHECK DIMENSIONS IN FIELDS 1,2             YTL17020
       TSX     CKDG2,4                                                  YTL17030
       CLA NA                POST MPY BY DIAGONAL                       YTL17040
       STO NC                                                           YTL17050
       PAX 0,2               NB                                         YTL17060
       ADD LB11                                                         YTL17070
       STA SCAR1+1                                                      YTL17080
       SUB LB11                                                         YTL17090
       ADD     =1                                                       YTL17100
       SUB MB                                                           YTL17110
       SUB NB                                                           YTL17120
       TNZ     MMMCF         NON-CONFORMABLE                            YTL17130
       CLA NA                                                           YTL17140
       SUB     =1                                                       YTL17150
       ALS 18                                                           YTL17160
       STD     SCAR1+5                                                  YTL17170
       LDQ MA                                                           YTL17180
       STQ MC                                                           YTL17190
       TSX     CHKCOR,4                                                 YTL17200
       LDQ     MA                                                       YTL17210
       MPY NA                                                           YTL17220
       XCA                                                              YTL17230
       PAX 0,1               MNA                                        YTL17240
       PAX     0,4                                                      YTL17250
       ADD LA11                                                         YTL17260
       STA SCAR1                                                        YTL17270
       SUB LA11                                                         YTL17280
       ADD LC11                                                         YTL17290
       ZET     ANULL                                                    YTL17300
       TRA     NMPY          A IS NULL                                  YTL17310
       ZET     BNULL                                                    YTL17320
       TRA     NMPY          B IS NULL                                  YTL17330
       STA     SCAR1+2                                                  YTL17340
SCAR1  LDQ 0,1               LA11+MNA                                   YTL17350
       FMP 0,2               LB11+NB                                    YTL17360
```

```
      STO 0,1               LC11+MNC                                    YTL17370
      TNX MMMR,1,1                                                      YTL17380
      TIX SCAR1,2,1                                                     YTL17390
      TXI SCAR1,2,0         NB-1                                        YTL17400
      REM PACKAGE 7.2   MMM13                                           YTL17410
      REM PRE MULTIPLY BY DIAGONAL                                      YTL17420
MMM13 TSX    CKDM12,4       CHECK DIMENSIONS IN FIELDS 1,2              YTL17430
      TSX    CKDG1,4                                                    YTL17440
      CLA MB                PRE MPY BY DIAGONAL                         YTL17450
      STO MC                                                            YTL17460
      PAX 0,1               NA                                          YTL17470
      ADD LA11                                                          YTL17480
      STA SCAR2                                                         YTL17490
      SUB LA11                                                          YTL17500
      ADD    =1                                                         YTL17510
      SUB MA                                                            YTL17520
      SUB NA                                                            YTL17530
      TNZ    MMMCF          NON CONFORMABLE                             YTL17540
      CLA NB                                                            YTL17550
      STO NC                                                            YTL17560
      TSX    CHKCOR,4                                                   YTL17570
      CLA    NB                                                         YTL17580
      PAX 0,4               NB                                          YTL17590
      SUB    =1                                                         YTL17600
      ALS 18                                                            YTL17610
      STD    SCAR2+5                                                    YTL17620
      LDQ MB                                                            YTL17630
      MPY NB                                                            YTL17640
      XCA                                                               YTL17650
      PAX 0,2               MNB                                         YTL17660
      ADD LB11                                                          YTL17670
      STA SCAR2+1                                                       YTL17680
      SUB LB11                                                          YTL17690
      ADD LC11                                                          YTL17700
      ZET    ANULL                                                      YTL17710
      TRA    NMPY1          A IS NULL                                   YTL17720
      ZET    BNULL                                                      YTL17730
      TRA    NMPY1          B IS NULL                                   YTL17740
      STA    SCAR2+2                                                    YTL17750
SCAR2 LDQ 0,1               LA11+NA                                     YTL17760
      FMP 0,2               LB11+MNB                                    YTL17770
      STO 0,2               LC11+MNC                                    YTL17780
      TNX MMMR,2,1                                                      YTL17790
      TIX SCAR2,4,1                                                     YTL17800
      TXI    SCAR2+6,4,0    NB-1                                        YTL17810
      TIX SCAR2,1,1                                                     YTL17820
      REM PACKAGE 7.3   MMM14                                           YTL17830
      REM POST MULTIPLY TRANSPOSE BY DIAGONAL                           YTL17840
MMM14 TSX    CKDM12,4       CHECK DIMENSIONS IN FIELDS 1,2              YTL17850
      TSX    CKDG2,4                                                    YTL17860
      CLA MA                POST MPY TRANSPOSE BY DIAGONAL              YTL17870
      STO NC                                                            YTL17880
      ADD LB11                                                          YTL17890
      STA SCAR3+2                                                       YTL17900
      SUB LB11                                                          YTL17910
      ADD    =1                                                         YTL17920
      SUB MB                                                            YTL17930
      SUB NB                                                            YTL17940
      TNZ    MMMCF          NON-CONFORMABLE                             YTL17950
      CLA NA                                                            YTL17960
      STO MC                                        YTL17970
      ALS 18                                        YTL17980
      STD      SCAR3+5                              YTL17990
      ADD      =1B17                                YTL18000
      STD PACH3                                     YTL18010
      TSX      CHKCOR,4                             YTL18020
      LDQ MA                                        YTL18030
      MPY NA                                        YTL18040
      XCA                                           YTL18050
      PAX      0,1                                  YTL18060
      PAX      0,4                                  YTL18070
      ADD LA11                                      YTL18080
      STA SCAR3+1                                   YTL18090
      SUB LA11                                      YTL18100
      PAX 0,2                                       YTL18110
      ADD LC11                                      YTL18120
      ZET      ANULL                                YTL18130
      TRA      NMPY         A IS NULL               YTL18140
      ZET      BNULL                                YTL18150
      TRA      NMPY         B IS NULL               YTL18160
      STA      SCAR3+3                              YTL18170
      TXI *+1,2,2                                   YTL18180
PACH3 TIX *+1,2,**      **=NA+1                     YTL18190
      TXI *+1,2,-2                                  YTL18200
      SXD      SCAR3+7,2                            YTL18210
SCAR3 LXA NC,2          NB                          YTL18220
      LDQ 0,1                   LA11+NMA            YTL18230
      FMP 0,2                   LB11+NB             YTL18240
      STO 0,4                   LC11+MNC            YTL18250
      TNX MMMR,4,1                                  YTL18260
      TNX      SCAR3+6,1,0      NA                  YTL18270
      TIX SCAR3+1,2,1                               YTL18280
      TXI SCAR3,1,0             NMA-NA-1            YTL18290
      REM PACKAGE 7.4     MMM15                     YTL18300
      REM PRE MULTIPLY TRANSPOSE BY DIAGONAL        YTL18310
MMM15 TSX      CKDM12,4         CHECK DIMENSIONS IN FIELDS 1,2    YTL18320
      TSX      CKDG1,4                              YTL18330
      CLA NB                    PRE MPY TRANSPOSE BY DIAGONAL     YTL18340
      STO MC                                        YTL18350
      PAX 0,1                   NB                  YTL18360
      SXD      SCAR4+4,1                            YTL18370
      ADD LA11                                      YTL18380
      STA SCAR4                                     YTL18390
      SUB LA11                                      YTL18400
      ADD      =1                                   YTL18410
      PAX 0,2           NB+1                        YTL18420
      SXD PACH4,2                                   YTL18430
      SUB MA                                        YTL18440
      SUB NA                                        YTL18450
      TNZ      MMMCF            NON-CONFORMABLE     YTL18460
      LDQ MB                                        YTL18470
      STQ NC                                        YTL18480
      TSX      CHKCOR,4                             YTL18490
      LDQ      MB                                   YTL18500
      MPY NB                                        YTL18510
      XCA                                           YTL18520
      PAX 0,2           NMB                         YTL18530
      TXI *+1,2,2                                   YTL18540
PACH4 TIX *+1,2,**      **=NB+1                     YTL18550
      TXI *+1,2,-2                                  YTL18560
```

```
       SXD      SCAR4+5,2                                               YTL18570
       PAX      0,4               NMC                                   YTL18580
       PAX      0,2               NMB                                   YTL18590
       ADD LB11                                                         YTL18600
       STA SCAR4+1                                                      YTL18610
       SUB LB11                                                         YTL18620
       ADD LC11                                                         YTL18630
       ZET      ANULL                                                   YTL18640
       TRA      NMPY              A IS NULL                             YTL18650
       ZET      BNULL                                                   YTL18660
       TRA      NMPY              B IS NULL                             YTL18670
       STA      SCAR4+2                                                 YTL18680
SCAR4  LDQ 0,1                    LA11+NA                               YTL18690
       FMP 0,2                    LB11+NMB                              YTL18700
       STO 0,4                    LC11+MNC                              YTL18710
       TNX MMMR,4,1                                                     YTL18720
       TIX SCAR4,2,0              NB                                    YTL18730
       TXI      SCAR4+6,2,0       NMB-NB-1                              YTL18740
       TIX SCAR4,1,1                                                    YTL18750
       REM PACKAGE 7.5   MMM16                                          YTL18760
       REM MULTIPLY DIAGONAL BY DIAGONAL, OR TWO MATRICES BY ELEMENT    YTL18770
MMM16  TSX      CKDM12,4          CHECK DIMENSIONS IN FIELDS 1,2        YTL18780
       TSX      CKDG1,4                                                 YTL18790
       TSX      CKDG2,4                                                 YTL18800
       CLA MA                     MPY DIAGONAL BY DIAGONAL              YTL18810
       SUB MB                                                           YTL18820
       TNZ XCHK1                                                        YTL18830
       CLA NA                                                           YTL18840
       SUB NB                                                           YTL18850
       TNZ      MMMCF             NON-CONFORMABLE                       YTL18860
       TRA XCHK2                                                        YTL18870
XCHK1  CLA MA                                                           YTL18880
       SUB NB                                                           YTL18890
       TNZ      MMMCF             NON-CONFORMABLE                       YTL18900
       CLA NA                                                           YTL18910
       SUB MB                                                           YTL18920
       TNZ      MMMCF             NON-CONFORMABLE                       YTL18930
XCHK2  CLA      =1                                                      YTL18940
       STO MC                                                           YTL18950
       LDQ MA                                                           YTL18960
       MPY NA                                                           YTL18970
       XCA                                                              YTL18980
       STO NC                                                           YTL18990
       TSX      CHKCOR,4                                                YTL19000
       CLA      NC                                                      YTL19010
       PAX 0,1                    NA,B,C                                YTL19020
       PAX      0,4                                                     YTL19030
       ADD LA11                                                         YTL19040
       STA ITR87                                                        YTL19050
       SUB LA11                                                         YTL19060
       ADD LB11                                                         YTL19070
       STA ITR87+1                                                      YTL19080
       SUB LB11                                                         YTL19090
       ADD LC11                                                         YTL19100
       ZET      ANULL                                                   YTL19110
       TRA      NMPY              A IS NULL                             YTL19120
       ZET      BNULL                                                   YTL19130
       TRA      NMPY              B IS NULL                             YTL19140
       STA      ITR87+2                                                 YTL19150
ITR87  LDQ 0,1                    LA11+NA                               YTL19160
```

```
       FMP 0,1                 LB11+NB                                  YTL19170
       STO 0,1                 LC11+NC                                  YTL19180
       TIX ITR87,1,1                                                    YTL19190
       TRA MMMR                                                         YTL19200
       REM                                                              YTL19210
       REM PACKAGE 8       MMM17                                        YTL19220
       REM ADD CONSTANT TIMES UNIT MATRIX                               YTL19230
       REM                                                              YTL19240
MMM17  CLA MA                  ADD KI                                   YTL19250
       SUB NA                                                           YTL19260
       TZE     *+3                                                      YTL19270
       CLA     =2              MATRIX NOT SQUARE                        YTL19280
       TRA     MMME                                                     YTL19290
       ZET     ANULL                                                    YTL19300
       STZ*    LA11                                                     YTL19310
       CLA MA                  LOOP CONTROL                             YTL19320
       STO MC                                                           YTL19330
       STO NC                                                           YTL19340
       ALS 18                                                           YTL19350
       STD     ITR88+3                                                  YTL19360
       LDQ MA                                                           YTL19370
       MPY NA                                                           YTL19380
       XCA                                                              YTL19390
       PAX     0,1                                                      YTL19400
       ADD LA11                                                         YTL19410
       STA ITR88                                                        YTL19420
       SUB LA11                                                         YTL19430
       ADD LC11                                                         YTL19440
       STA     ITR88+4                                                  YTL19450
       CLA 2,4                                                          YTL19460
       STA ITR88+2                                                      YTL19470
       TSX     CKDM1,4         CHECK DIMENSIONS IN FIELD 1              YTL19480
       TSX     CHKCOR,4                                                 YTL19490
       CLA     =1                                                       YTL19500
       PAX 0,2                 ONE                                      YTL19510
ITR88  CLA 0=1                 TA11+MNA                                 YTL19520
       TIX     ITR88+4,2,1                                              YTL19530
       FAD 0                   LOC B                                    YTL19540
       TXI     ITR88+4,2,0     MA                                       YTL19550
       STO 0,1                 LC11+MNC                                 YTL19560
       TIX ITR8 ,1,1                                                    YTL19570
       CLA     LA11                                                     YTL19580
       SUB     LC11                                                     YTL19590
       TZE     MMMR                                                     YTL19600
       CLA     WDMNL                                                    YTL19610
       ZET     ANULL                                                    YTL19620
       STO*    LA11                                                     YTL19630
       TRA MMMR                                                         YTL19640
*                                                                       YTL19650
*              PACKAGE 9,  MMM18  MATRIX INVERSION                      YTL19660
*              USES INV4,  7094 INVERSION WHICH UTILIZES                YTL19670
*              THE HARDWARE DOUBLE PRECISION                            YTL19680
*                                                                       YTL19690
*              FIELD 2 OPTION DESCRIPTION                               YTL19700
*                                                                       YTL19710
*              FIELD 2 = -1, PRINT DETERMINANT                          YTL19720
*              FIELD 2 = -2 , HAVE CONDITIONING INFO. PRINTED           YTL19730
*              FIELD 2 = -3 , DO BOTH                                   YTL19740
*                                                                       YTL19750
*                                                                       YTL19760
```

```
MMM18  TSX     CKDM1,4        CHECK DIMENSIONS                          YTL19770
       CLA     MA                                                       YTL19780
       SUB     NA                                                       YTL19790
       TZE     *+3                                                      YTL19800
       CLA     =2             NOT SQUARE                                YTL19810
       TRA     MMME                                                     YTL19820
       CLA     ANULL                                                    YTL19830
       TZE     NOTNUL                                                   YTL19840
       CLA     =11                                                      YTL19850
       TRA     MMME                                                     YTL19860
NOTNUL CLA     NA                                                       YTL19870
       STO     MC                                                       YTL19880
       STO     NC                                                       YTL19890
       LDQ     NA                                                       YTL19900
       MPY     NA                                                       YTL19910
       STQ     NSQ                                                      YTL19920
       RQL     1                                                        YTL19930
       STQ     TWONSQ         2NSQ                                      YTL19940
       CLA     TWONSQ                                                   YTL19950
       ADD     NA                                                       YTL19960
       ADD     NA                                                       YTL19970
       ADD     =6                                                       YTL19980
       ADD     LC11           LC11+2*N**2+2*N+6                         YTL19990
       CAS     HICORE                                                   YTL20000
       TRA     OVER                                                     YTL20010
       TRA     *+1                                                      YTL20020
       CLA     LC11                                                     YTL20030
       LBT                                                              YTL20040
       TRA     *+2            MAKE SURE ADDRESS IS EVEN                 YTL20050
       ADD     =1                                                       YTL20060
       STA     GO+4                                                     YTL20070
       CLA     LA11                                                     YTL20080
       ADD     NSQ                                                      YTL20090
       STA     GET1                                                     YTL20100
       CLA     GO+4                                                     YTL20110
       ADD     TWONSQ                                                   YTL20120
       STA     STO1                                                     YTL20130
       CLA     LC11                                                     YTL20140
       CAS     LA11                                                     YTL20150
       TRA     TOPFST         IF INVERTED FORWARDS, MOVE FROM TOP DOWN  YTL20160
       TRA     TOPFST         IF INVERTED OVER ITSELF, MOVE FROM TOP DOWNYTL20170
BOTFST LXA     NSQ,1          IF INVERTED BACKWARDS,MOVE  FROM BOTTOM FSTYTL20180
       LXA     TWONSQ,2                                                 YTL20190
GET1   CLA     **,1           LA11 + NSQ                                YTL20200
STO1   STO     **,2           LC11(EVEN) + 2*N**2                       YTL20210
       TIX     *+1,2,1                                                  YTL20220
       STZ*    *-2                                                      YTL20230
       TIX     *+1,2,1                                                  YTL20240
       TIX     GET1,1,1                                                 YTL20250
       TRA     INVERT                                                   YTL20260
TOPFST LXA     NSQ,1          EXPAND THIS WAY FOR INVERSION OVER ITSELF YTL20270
       SXD     LPEND,1                                                  YTL20280
       AXT     1,1                                                      YTL20290
       AXT     1,2                                                      YTL20300
GET2   CLA*    GET1                                                     YTL20310
       STZ*    STO1                                                     YTL20320
       TXI     *+1,2,1                                                  YTL20330
       STO*    STO1                                                     YTL20340
       TXI     *+1,2,1                                                  YTL20350
       TXI     *+1,1,1                                                  YTL20360
```

```
 LPEND TXL    GET2,1,**         N**2 IN DECREMENT                                YTL20370
INVERT CLA    YMBB              CHECK FOR OPTIONAL DIAGONAL TERM PRINT           YTL20380
       TZE    GO                                                                 YTL20390
       TMI    *+3                                                                YTL20400
       CLA    =35               FIELD MUST BE NEGATIVE                           YTL20410
       TRA    MMME                                                               YTL20420
       PAX    0,7                                                                YTL20430
       TXH    *-3,7,3           ONLY 1,2, OR 3                                   YTL20440
       TXL    GO+1,7,1          1 IS JUST DETERMINANT                            YTL20450
       CLA    NA                                                                 YTL20460
       SSM                                                                       YTL20470
       STO    NA                                                                 YTL20480
       TRA    *+2                                                                YTL20490
    GO LXA    =0,7              CLEAR XR7 IF FIELD 2=0                           YTL20500
       CALL   INV4DS(**,NA,IRR1,IRR2,SCALE,DET,NDETXP)                           YTL20510
       ZAC                                                                       YTL20520
       STP    NA                                                                 YTL20530
       CLA    IRR1                                                               YTL20540
       TZE    GOOD                                                               YTL20550
INVE   CALL   .FWRD.(.UN06.,INVFMT)                ERROR PRINT                   YTL20560
       CLA    IRR1                                                               YTL20570
       TSX    .FCNV.,4                                                           YTL20580
       CLA    IRR2                                                               YTL20590
       TSX    .FCNV.,4                                                           YTL20600
       CLA    SCALE                                                              YTL20610
       TSX    .FCNV.,4                                                           YTL20620
       CALL   .FFIL.                                                             YTL20630
  GOOD LXA    NSQ,1                                                              YTL20640
       LXA    TWONSQ,2                                                           YTL20650
       CLA    LC11                                                               YTL20660
       ADD    NSQ                                                                YTL20670
       STA    STO2                                                               YTL20680
 SQEZE CLA*   STO1                                                               YTL20690
       TIX    *+1,2,1                                                            YTL20700
       LDQ*   STO1                                                               YTL20710
       FRN                                                                       YTL20720
  STO2 STO    **,1                                                               YTL20730
       TIX    *+1,2,1                                                            YTL20740
       TIX    SQEZE,1,1                                                          YTL20750
       CLA    IRR1                                                               YTL20760
       TZE    *+3                                                                YTL20770
       CLA    =32                                                                YTL20780
       TRA    MMME                                                               YTL20790
       PXA    0,7               CHECK OPTION FOR DET PRINT                       YTL20800
       TZE    MMMR                                                               YTL20810
       TRA    *+4,7                                                              YTL20820
       TRA    PNTDET            FIELD 2 = -3                                     YTL20830
       TRA    MMMR              FIELD 2 = -2                                     YTL20840
PNTDET CALL   .FWRD.(.UN06.,DETPNT)                                              YTL20850
       CLA    MA                                                                 YTL20860
       TSX    .FCNV.,4                                                           YTL20870
       CLA    NA                                                                 YTL20880
       TSX    .FCNV.,4                                                           YTL20890
       CLA*   YMAA                                                               YTL20900
       TSX    .FCNV.,4                                                           YTL20910
       CLA    DET                                                                YTL20920
       TSX    .FCNV.,4                                                           YTL20930
       CLA    NDETXP                                                             YTL20940
       TSX    .FCNV.,4                                                           YTL20950
       CALL   .FFIL.                                                             YTL20960
```

```
        TRA    MMMR                                                     YTL20970
*                                                                       YTL20980
*                                                                       YTL20990
*                                                                       YTL21000
MMM19   ZET    2,4                                                      YTL21010
        TRA    TRY3                                                     YTL21020
        NZT    3,4                                                      YTL21030
        TRA    RDBCD                                                    YTL21040
        CLA    =16            FIELD 2 OR FIELD 3 =0                     YTL21050
        TRA    MMME                                                     YTL21060
  TRY3  ZET    3,4                                                      YTL21070
        TRA    RDDECM                                                   YTL21080
        TRA    *-4                                                      YTL21090
RDBCD   CLA    4,4            FIELDS 2 AND 3 ARE ZERO                   YTL21100
        TZE    RDBCD1         READ 1 BCD CARD                           YTL21110
        STO    TAP1                                                     YTL21120
        CALL   .FVIO.(TAP1,TAPIB)                                       YTL21130
RDBCD1  CALL   .FRDD.(TAPIB,TLEIN)                                      YTL21140
        CLA    YMAA                                                     YTL21150
        STA    IN+3                                                     YTL21160
 IN     CALL   .FSLI.(**,=14)                                           YTL21170
        CALL   .FRTN.                                                   YTL21180
        TRA    DONE                                                     YTL21190
RDDECM  CLA    4,4                                                      YTL21200
        TNZ    *+2                                                      YTL21210
        CLA    TAP            CURRENT TAPE                              YTL21220
        STO    READ+7                                                   YTL21230
        SUB    =5                                                       YTL21240
        TZE    GOODTP         TAPE 5 IS PERMITTED                       YTL21250
        CLA    READ+7                                                   YTL21260
        STO    TAPE                                                     YTL21270
        TSX    TPCK,4         CHECK TAPE NO.                            YTL21280
        LXD    SPOT4,4                                                  YTL21290
GOODTP  CLA    3,4                                                      YTL21300
        STO    READ+5                                                   YTL21310
        CLA    2,4                                                      YTL21320
        STO    READ+4                                                   YTL21330
        CLA    1,4                                                      YTL21340
        STO    READ1+3                                                  YTL21350
READ1   CALL   KRD(**,=1,IRROR,KRDP4,KRDP5,=0,KRDP7)                    YTL21360
        STO    TEMP           CARD COUNT                                YTL21370
        CLA    IRROR                                                    YTL21380
        TZE    CK19NL-2                                                 YTL21390
        XCA                                                             YTL21400
        MPY    THOUSN                                                   YTL21410
        XCA                                                             YTL21420
        ADD    TEMP                                                     YTL21430
        ADD    MILYN                                                    YTL21440
        TRA    MMME                                                     YTL21450
        NZT*   READ1+3                                                  YTL21460
        STZ*   READ1+3                                                  YTL21470
CK19NL  CLA*   LA11                                                     YTL21480
        SUB    WDMNL          ARE WE READING IN TO A NULL MATRIX        YTL21490
        TNZ    DONE           IF NOT, ALLDONE                           YTL21500
        LDQ*   MMMA                                                     YTL21510
        MPY*   MMNA                                                     YTL21520
        XCA                                                             YTL21530
        SUB    =1             M*N-1                                     YTL21540
        PAX    0,1                                                      YTL21550
        ADD    =1                                                       YTL21560
```

```
       ADD     LA11          LA11+M*N                                   YTL21570
       STA     *+1                                                      YTL21580
       CLA     **,1                                                     YTL21590
       TNZ     CLRWRD        IF NON-ZERO ELEMENT, CLEAR CODE WORD       YTL21600
       TIX     *-2,1,1                                                  YTL21610
       TRA     DONE                                                     YTL21620
CLRWRD STZ*    LA11          CLEAR CODE WORD                            YTL21630
       TRA     DONE                                                     YTL21640
       REM                                                              YTL21650
*              MMM20 - OUTPUT ROUTINE FOR YTL01                         YTL21660
*              CONVERTED TO FORTRAN METHOD IN JUNE 1962                 YTL21670
*              NEEDS (STH), (FIL), (TSH), (RTN)                         YTL21680
*              INSTRUCTION CARD IS,  FIELD 1 = LOCATION OF MATRIX       YTL21690
*                                            = 0 IF COMMENT IS TO BE    YTL21700
*                                              PRINTED ON LINE - WORKS  YTL21710
*                                              WITH CORE OR TAPE COMMENTYTL21720
*                                    FIELD 2 = 0, FOR NEW PAGE          YTL21730
*                                            = 1 FOR NO SPACING         YTL21740
*                                    FIELD 3 = 0 TO PRINT MATRIX,CHKSUM YTL21750
*                                            = 1 FOR CHECKSUM ONLY      YTL21760
*                                    FIELD 4 = 0, IF MATRIX NO. WANTED  YTL21770
*                                            = K, IF 1 FULL TITLE CARD  YTL21780
*                                              TO BE READ FROM TAPE K   YTL21790
*                                            = 8000 OR GREATER THE      YTL21800
*                                              COMMENT COMES FROM CORE  YTL21810
*                                              THIS IS CONNECTED WITH   YTL21820
*                                              NEW OPTION IN OP. CODE 19YTL21830
*                                    FIELD 5 = OP. CODE 20              YTL21840
*              MMM23A-ENTRY POINT TO ALLOW MMM23 TO UTILIZE THE         YTL21850
*                     MATRIX IDENTIFICATION SECTION OF MMM20            YTL21860
*              FIRST PAGE HEADING AND NEW PAGE PRINT ARE                YTL21870
*              USED BY MMM23 ALSO                                       YTL21880
MMM23A CLA     =1            MAP ROUTINE WAS CALLED                     YTL21890
       STO     MAP                                                      YTL21900
       TRA     MMM20+1                                                  YTL21910
 MMM20 STZ     MAP                                                      YTL21920
       NZT     1,4           IS THIS AN ON LINE COMMENT                 YTL21930
       TRA     NSPACE        YES, DO NOT CHECK DIMENSIONS               YTL21940
       CLA     MA                                                       YTL21950
       ADD     NA                                                       YTL21960
       TZE     *+2                                                      YTL21970
       TSX     CKDM1,4       CHECK DIMENSIONS IN FIELD 1                YTL21980
       CLA     YMBB                                                     YTL21990
       STO     SPACE         IS FIELD 2 BLANK                           YTL22000
       TNZ     NSPACE                                                   YTL22010
       CALL    .FWRD.(.UN06.,NPAGE)                                     YTL22020
       CALL    .FFIL.                                                   YTL22030
NSPACE CLA     YMNC                                                     YTL22040
       STO     TTLE                                                     YTL22050
       TZE     PNTNO         IS FIELD 4 BLANK                           YTL22060
       CAS     =22           IS IT A TAPE NO.                           YTL22070
       TRA     *+3           NO                                         YTL22080
       TRA     TPTLE         YES                                        YTL22090
       TRA     TPTLE         YES                                        YTL22100
       AXT     14,1          CORE TITLE, COPY INTO TITLE                YTL22110
       ADD     =14                                                      YTL22120
       ADD     YSHIFT                                                   YTL22130
       STA     *+1                                                      YTL22140
       CLA     **,1                                                     YTL22150
       STO     TITLE+14,1                                               YTL22160
       TIX    *-2,1,1                                                  YTL22170
       TRA    PNTTLE                                                   YTL22180
TPTLE  CALL   .FVIO.(YMNC,TAP1IB)                                      YTL22190
       CALL   .FRDD.(TAP1IB,TLEIN)                                     YTL22200
       CALL   .FSLI.(TITLE,=14)                                        YTL22210
       CALL   .FRTN.                                                   YTL22220
PNTTLE CLA    YMAA              CHECK FOR ON LINE PRINT                YTL22230
       TNZ    WRTCMT                                                   YTL22240
       CALL   .FPRN.(TLEOUT)                                           YTL22250
       CALL   .FSLO.(TITLE,=14)                                        YTL22260
       CALL   .FFIL.                                                   YTL22270
       TRA    DONE                                                     YTL22280
WRTCMT CALL   .FWRD.(.UN06.,TLEOUT)                                    YTL22290
       CALL   .FSLO.(TITLE,=14)                                        YTL22300
       CALL   .FFIL.                                                   YTL22310
       CLA    =14               LINE 1 OF ROW 1 STARTS ON LINE 14      YTL22320
       STO    LINE                                                     YTL22330
       TRA    PNTNO+2                                                  YTL22340
 PNTNO CLA    =12               LINE 1 OF ROW 1 STARTS ON LINE 12      YTL22350
       STO    LINE                                                     YTL22360
       NZT    YMAA                                                     YTL22370
       TRA    NOTITL                                                   YTL22380
       CLA    MA                                                       YTL22390
       ADD    NA                                                       YTL22400
       TNZ    PRNTFL            GO AHEAD AND PRINT IF M OR N IS NON-ZERO YTL22410
       ZET    TTLE              DIMENSIONS ARE ZERO, WAS A TITLE PRINTED YTL22420
       TRA    DONE              YES, 0 DIMENSIONS HERE CAUSE AN EXIT   YTL22430
NOTITL CLA    =7                                                       YTL22440
       TRA    MMME              NO,THEY ARE TRYING TO PRINT A 0 BY 0 MATRIXYTL22450
PRNTFL CALL   .FWRD.(.UN06.,MATNO)                                     YTL22460
       CLA*   YMAA                                                     YTL22470
       TSX    .FCNV.,4                                                 YTL22480
       CALL   .FFIL.                                                   YTL22490
  CKSM LDQ    MA                                                       YTL22500
       MPY    NA                                                       YTL22510
       XCA                                                             YTL22520
       PAX    0,2               LOAD INDEX FOR FORMAT CHECK            YTL22530
       ADD    =3                                                       YTL22540
       PAX    0,1                                                      YTL22550
       ADD    YMAA                                                     YTL22560
       STA    *+2                                                      YTL22570
       PXA    0,0                                                      YTL22580
       ACL    **,1              COMPUTE CHECK SUM OF MATRIX            YTL22590
       TIX    *-1,1,1                                                  YTL22600
       SLW    CHKSUM                                                   YTL22610
       CALL   .FWRD.(.UN06.,ORDSUM)                                    YTL22620
       CLA    MA                                                       YTL22630
       TSX    .FCNV.,4                                                 YTL22640
       CLA    NA                                                       YTL22650
       TSX    .FCNV.,4                                                 YTL22660
       CLA    CHKSUM                                                   YTL22670
       TSX    .FCNV.,4                                                 YTL22680
       CALL   .FFIL.                                                   YTL22690
       CLA    ANULL                                                    YTL22700
       TZE    ANN20                                                    YTL22710
       CALL   .FWRD.(.UN06.,NULMAT)                                    YTL22720
       CALL   .FFIL.                                                   YTL22730
       NZT    MAP                                                      YTL22740
       TRA    OUT20             NOT MAP                                YTL22750
 ANN20 ZET    MAP               WAS MAPPING CALLED                     YTL22760
```

```
        TRA    MMM23          YES                                     YTL22770
        ZET    YMCC           IS ONLY CHECK SUM WANTED                YTL22780
        TRA    CSMOLY         YES                                     YTL22790
        PXA    0,2            NO                                      YTL22800
        ADD    LA11                                                   YTL22810
        STA    FMTCK                                                  YTL22820
        AXT    0,1                                                    YTL22830
FMTCK   CLA    **,2             EXAMINE MATRIX TO FIND 1              YTL22840
        TNZ    *+2                                                    YTL22850
        TXI    *+3,1,1                                                YTL22860
        ANA    =0377400000000   FLOATING POINT ELEMENT                YTL22870
        TNZ    FLPPT            IF FL. PT , USE E FORMAT              YTL22880
        TIX    FMTCK,2,1                                              YTL22890
        LDQ    MA                                                     YTL22900
        MPY    NA                                                     YTL22910
        XCA                                                           YTL22920
        STZ    CHKSUM                                                 YTL22930
        SXA    CHKSUM,1                                               YTL22940
        SUB    CHKSUM                                                 YTL22950
        TZE    FLPPT                                                  YTL22960
        STZ    WHCHFT         0 IF INTEGER FORMAT                     YTL22970
        TRA    FMTDEF                                                 YTL22980
FLPPT   CLA    =1                                                     YTL22990
        STO    WHCHFT         =1 IF FLOATING POINT FORMAT             YTL23000
FMTDEF  CLA    =1                                                     YTL23010
        STO    I              COUNT OF ROWS                           YTL23020
        CLA    LA11                                                   YTL23030
        STA    PRNT                                                   YTL23040
        STZ    CHKSUM         ZERO FOR NEW PAGE TRANSFER              YTL23050
LOOP    CLA    NA                                                     YTL23060
        PAX    0,2            COLUMN COUNT                            YTL23070
        AXT    7,1            START COUNT OF ELEMENTS ON ONE LINE     YTL23080
        ADD    PRNT           INCREMENT PRINT ADDRESS BY 1 ROW        YTL23090
        STA    PRNT                                                   YTL23100
PRNT1   CLA    WHCHFT                                                 YTL23110
        TZE    FIXPRT                                                 YTL23120
        CALL   .FWRD.(.UN06.,FLPPNT)                                  YTL23130
        TRA    PRNT-2                                                 YTL23140
FIXPRT  CALL   .FWRD.(.UN06.,INTPNT)                                  YTL23150
        CLA    I              ROW  INDEX                              YTL23160
        TSX    .FCNV.,4                                               YTL23170
PRNT    CLA    **,2                                                   YTL23180
        TSX    .FCNV.,4                                               YTL23190
        TIX    COLUMN,2,1     IS THIS ROW FINISHED                    YTL23200
        CALL   .FFIL.                                                 YTL23210
        CLA    I              YES, ARE ALL ROW FINISHED               YTL23220
        CAS    MA                                                     YTL23230
        TRA    OUT20                                                  YTL23240
        TRA    OUT20                                                  YTL23250
        ADD    =1             MORE ROWS LEFT                          YTL23260
        STO    I                                                      YTL23270
        CLS    LINE           FIND OUT IF THERE ARE AT LEAST          YTL23280
        SUB    =1             3 LINES AVAILABLE FOR THIS NEW ROW      YTL23290
        ADD    =54                                                    YTL23300
        LDQ    =3                                                     YTL23310
        TLQ    KEPPNT                                                 YTL23320
        XCA                   3 OR LESS LINES AVAILABLE = K           YTL23330
        MPY    =7                                                     YTL23340
        XCA                                                           YTL23350
        CAS    NA             IS K SUFFICIENT TO HOLD 1 ROW           YTL23360
```

```
       TRA     KEPPNT                                                       YTL23370
       TRA     KEPPNT                                                       YTL23380
       CLA     =1                                                           YTL23390
       STO     CHKSUM                                                       YTL23400
       TRA     NEWPGE             NOT ENOUGH ,START NEW PAGE                YTL23410
COLUMN TIX     PRNT,1,1           STILL PRINTING ROW I, SAME LINE           YTL23420
       AXT     7,1                START COUNT OF ELEMENTS IN A LINE         YTL23430
       CLA     SPACE              ARE WE SUPPRESSING NEW PAGES              YTL23440
       TNZ     PRNT               IGNORE LINE COUNT IF SPACE NOT ZERO       YTL23450
       CLA     LINE               START NEW LINE                            YTL23460
       ADD     =1                                                           YTL23470
       STO     LINE                                                         YTL23480
       STZ     CHKSUM             ZERO CONTROL FOR NEW PAGE TRANSFER        YTL23490
       CLA     LINE                                                         YTL23500
       CAS     =54                ARE WE ABOUT TO PRINT LINE 55             YTL23510
       TRA     CLOSIT                                                       YTL23520
       TRA     PRNT                                                         YTL23530
       TRA     PRNT                                                         YTL23540
CLOSIT CALL    .FFIL.                                                       YTL23550
NEWPGE CLA     TTLE               WHICH TITLE TO PRINT                      YTL23560
       TNZ     CDTLE                                                        YTL23570
       CALL    .FWRD.(.UN06.,NWPGE1)                                        YTL23580
       CLA*    YMAA                                                         YTL23590
       TSX     .FCNV.,4                                                     YTL23600
       CALL    .FFIL.                                                       YTL23610
       TRA     BACK                                                         YTL23620
CDTLE  CALL    .FWRD.(.UN06.,NWPGE2)                                        YTL23630
       CALL    .FSLO.(TITLE,=14)                                            YTL23640
       CALL    .FFIL.                                                       YTL23650
  BACK CLA     =8                 RESET LINE COUNT                          YTL23660
       STO     LINE                                                         YTL23670
       PXA     0,0                                                          YTL23680
       CAS     CHKSUM                                                       YTL23690
       TRA     STPGE              RETURN TO MMM23                           YTL23700
       TRA     PRNT1              PRINT ROW INDEX AT START OF PAGE          YTL23710
       TRA     LOOP               NEW ROW AT START OF PAGE                  YTL23720
KEPPNT CLA     SPACE              DO NOT INCREMENT COUNT IF SPACING IGNORED YTL23730
       TNZ     LOOP                                                         YTL23740
       CLA     LINE               START NEW ROW ON CURRENT PAGE             YTL23750
       ADD     =2                                                           YTL23760
       STO     LINE                                                         YTL23770
       TRA     LOOP                                                         YTL23780
CSMOLY CALL    .FWRD.(.UN06.,CSMPT)                                         YTL23790
       CALL    .FFIL.                                                       YTL23800
       TRA     DONE                                                         YTL23810
OUT20  CALL    .FWRD.(.UN06.,FINAL)                                         YTL23820
       CALL    .FFIL.                                                       YTL23830
       TRA     DONE                                                         YTL23840
*              PACKAGE 12 MMM21                                             YTL23850
*              DIAGONAL INVERSE                                             YTL23860
 MMM21 TSX     CKDM1,4                                                      YTL23870
       TSX     CKDG1,4                                                      YTL23880
       CLA     ANULL                                                        YTL23890
       TZE     *+3                                                          YTL23900
       CLA     =11                NULL MATRIX WILL NOT INVERT               YTL23910
       TRA     MMME                                                         YTL23920
       LDQ     MA                                                           YTL23930
       STQ     MC                                                           YTL23940
       MPY     NA                                                           YTL23950
       XCA                                                                  YTL23960
```

```
      PAX    0,1                                                       YTL23970
      ADD    LA11                                                      YTL23980
      STA    CORE+1                                                    YTL23990
      SUB    LA11                                                      YTL24000
      ADD    LC11                                                      YTL24010
      STA    CORE+2                                                    YTL24020
      CLA    NA                                                        YTL24030
      STO    NC                                                        YTL24040
      TSX    CHKCOR,4                                                  YTL24050
CORE  CLA    =1.0                                                      YTL24060
      FDP    **,1                                                      YTL24070
      STQ    **,1                                                      YTL24080
      TIX    CORE,1,1                                                  YTL24090
      DCT                                                              YTL24100
      TRA    *+2                                                       YTL24110
      TRA    MMMR                                                      YTL24120
      CLA    =10                                                       YTL24130
      TRA    MMME                                                      YTL24140
*            PACKAGE 13 MMM22                                          YTL24150
*            FORM P1 MATRIX                                            YTL24160
MMM22 TSX    CKDM12,4          CHECK DIMENSIONS IN FIELDS 1,2          YTL24170
      ZET    ANULL                                                     YTL24180
      STZ*   LA11              A IS NULL                               YTL24190
      ZET    BNULL                                                     YTL24200
      STZ*   LB11              B IS NULL                               YTL24210
      CLA    =25                                                       YTL24220
      STO    NC                                                        YTL24230
      LDQ    MA                                                        YTL24240
      MPY    NA                                                        YTL24250
      XCA                                                              YTL24260
      STO    MC                                                        YTL24270
      TSX    CHKCOR,4                                                  YTL24280
      CLA    MC                                                        YTL24290
      PAX    0,4                                                       YTL24300
      ADD    LA11                                                      YTL24310
      STA    INNR+6                                                    YTL24320
      SUB    LA11                                                      YTL24330
      ADD    LB11                                                      YTL24340
      STA    INNR+2                                                    YTL24350
      CLA    LC11                                                      YTL24360
      STA    INNR                                                      YTL24370
      LDQ    NB                                                        YTL24380
      MPY    MB                                                        YTL24390
      XCA                                                              YTL24400
      SUB    MC                                                        YTL24410
      TZE    OUTR                                                      YTL24420
      TRA    MMMCF                                                     YTL24430
OUTR  AXT    25,2                                                      YTL24440
      CAL    INNR                                                      YTL24450
      ACL    =25                                                       YTL24460
      SLW    INNR                                                      YTL24470
      CLA    =1.0                                                      YTL24480
MIDL  AXT    5,1                                                       YTL24490
      STO    CELL1                                                     YTL24500
INNR  STO    **,2                                                      YTL24510
      XCA                                                              YTL24520
      FMP    **,4                                                      YTL24530
      TXI    *+1,2,-1                                                  YTL24540
      TIX    INNR,1,1                                                  YTL24550
      LDQ    CELL1                                                     YTL24560
```

```
        FMP    **,4                                                     YTL24570
        TIX    MIDL,2,0                                                 YTL24580
        TIX    OUTR,4,1                                                 YTL24590
        CLA    WDMNL                                                    YTL24600
        ZET    ANULL                                                    YTL24610
        STO*   LA11                                                     YTL24620
        ZET    BNULL                                                    YTL24630
        STO*   LB11                                                     YTL24640
        TRA    MMMR                                                     YTL24650
*              MMM23 - MATRIX MAPPING OR CHECKSUM ROUTINE               YTL24660
*              ADDED TO YTL01 JUNE 1962                                 YTL24670
*              NEEDS (STH), (FIL), AND MMM20                            YTL24680
*              INSTRUCTION CARD IS,  FIELD 1 = LOCATION OF MATRIX       YTL24690
*                                    FIELD 2 = 0 FOR NEW PAGE           YTL24700
*                                            = 1 FOR NO SPACING         YTL24710
*                                    FIELD 3 = ADDRESS OF NUMBER FOR    YTL24720
*                                              ZERO LEVEL CHECKING-     YTL24730
*                                             A(I,J) MAPPED AS ZERO IF  YTL24740
*                                              LESS THAN OR EQUAL TO    YTL24750
*                                              THIS NUMBER.             YTL24760
*                                    FIELD 4 = 0 IF MATRIX NO. WANTED   YTL24770
*                                            = K IF 1 FULL TITLE        YTL24780
*                                                CARD TO BE READ        YTL24790
*                                                FROM TAPE K            YTL24800
*                                    FIELD 5 = OP. CODE 23              YTL24810
*              PICK UP A NUMBER OF VARIABLES FROM MMM20 WHICH ARE       YTL24820
*              MARKED BY ASTRISK IN COL 73                              YTL24830
MMM23   ZET    ANULL                                                    YTL24840
        TRA    THRU           A IS NULL                                 YTL24850
        NZT    YMCC                                                     YTL24860
        TRA    STOZE                                                    YTL24870
        CLA*   YMCC                                                     YTL24880
        SSP                                                             YTL24890
        STO    LEVEL          STORE NUMBER FOR ZERO LEVEL TESTING       YTL24900
        TRA    *+2                                                      YTL24910
STOZE   STZ    LEVEL                                                    YTL24920
        CALL   .FWRD.(.UN06.,LVLPT)                                     YTL24930
        CLA    LEVEL                                                    YTL24940
        TSX    .FCNV.,4                                                 YTL24950
        CALL   .FFIL.                                                   YTL24960
        CLA    LINE           INCREASE LINE COUNT FOR EXTRA TITLE       YTL24970
        ADD    =2                                                       YTL24980
        STO    LINE                                                     YTL24990
        STZ    SVCLPT         ZERO COUNT FOR COLUMN I.D. COUNT          YTL25000
        STZ    NCLPT          ZERO FLAG FOR NEW PAGE COLUMN I.D.        YTL25010
        CLA    =110           GO AHEAD WITH MAPPING                     YTL25020
        LDQ    NA                                                       YTL25030
        TLQ    *+3                                                      YTL25040
        CLA    =34            TOO BIG TO MAP                            YTL25050
        TRA    MMME                                                     YTL25060
        CLA    =9             NO, PROCEED WITH MAPPING                  YTL25070
        TLQ    LESS10         LESS THAN 10 COLUMNS                      YTL25080
        XCA                   MORE THAN 10 COLUMNS                      YTL25090
        SUB    =10            FIND NUMBER OF COLUMN LABELS - LABEL      YTL25100
        AXT    1,1            TO GO AT EACH INCREMENT OF 10 COLUMNS     YTL25110
        SUB    =10                                                      YTL25120
        TMI    *+2            IF N - K*10 = 0, IT WILL BE + 0           YTL25130
        TXI    *-2,1,1        COUNT OF LABELS LEFT IN XR1               YTL25140
        PXA    0,1                                                      YTL25150
        PAX    0,2                                                      YTL25160
```

```
       STO     SVCLPT        SAVE COUNT OF LABELS                       YTL25170
CLPT   CALL    .FWRD.(.UN06.,COLPT)                                     YTL25180
       PXA     0,0                                                      YTL25190
   PP1 ADD     =10                                                      YTL25200
       PAX     0,5                                                      YTL25210
       TSX     .FCNV.,4      PRINT LABEL ON EACH 10 COLUMNS             YTL25220
       PXA     0,5                                                      YTL25230
       TIX     PP1,1,1                                                  YTL25240
       CALL    .FFIL.                                                   YTL25250
       CALL    .FWRD.(.UN06.,COLPT1)             PRINT TO IDENTIFY COLS.YTL25260
       CLA     =020000000000                                            YTL25270
       TSX     .FCNV.,4                                                 YTL25280
       TIX     *-2,2,1                                                  YTL25290
       CALL    .FFIL.                                                   YTL25300
       CLA     NCLPT         IS THIS THE FIRST PAGE                     YTL25310
       TNZ     NSPCE-2       NO, THIS WAS PRINT ON NEW PAGE             YTL25320
LESS10 CLA     =10                                                      YTL25330
       STO     TESTI         COUNT FOR IDENTIFYING EVERY 10 TH ROW      YTL25340
       CLA     =1                                                       YTL25350
       STO     I             ROW COUNT                                  YTL25360
       CLA     LA11          ADDRESS OF MATRIX -                        YTL25370
       STA     TESTIJ                                                   YTL25380
       CLA     =-1                                                      YTL25390
       STO     CHKSUM        SET UP RETURN FROM MMM20 NEW PAGE PRINT    YTL25400
MRROWS CLA     NA                                                       YTL25410
       PAX     0,1           NUMBER OF COLUMNS                          YTL25420
       ADD     TESTIJ        INCREMENT ADDRESS OF CURRENT ROW           YTL25430
       STA     TESTIJ                                                   YTL25440
       CLA     =0606060606060                                           YTL25450
       AXT     19,2                                                     YTL25460
       STO     ROW+19,2      FILL 1 ROW OF MAP WITH BLANKS              YTL25470
       TIX     *-1,2,1                                                  YTL25480
       PXA     ROW,0                                                    YTL25490
       CLA     *-1                                                      YTL25500
       STA     RWCELL        SET UP ADDRESS OF 1 ST CELL OF ROW         YTL25510
       AXT     6,2                                                      YTL25520
       CAL     ZERO+6,2                                                 YTL25530
RWCELL ANS     **            ZERO CURRENT COLUMN POSITION               YTL25540
TESTIJ CLA     **,1                                                     YTL25550
       SSP                                                              YTL25560
       CAS     LEVEL         IS ELEMENT (I,J) GREATER THAN GIVEN LEVEL  YTL25570
       TRA     *+3           YES                                        YTL25580
       TRA     NCHNG         EQUAL                                      YTL25590
       TRA     NCHNG         LESS THAN                                  YTL25600
       CAL     DOLSGN+6,2    GREATER THAN LEVEL                         YTL25610
       ORS*    RWCELL        PUT $ IN CURRENT POSITION                  YTL25620
       TRA     *+3                                                      YTL25630
 NCHNG CAL     POINT+6,2     PUT DECIMAL POINT IN IF NO. IS BELOW LEVEL YTL25640
       ORS*    RWCELL                                                   YTL25650
       TIX     KPGONG,1,1                                               YTL25660
       CLA     SPACE                                                    YTL25670
       TNZ     NSPCE                                                    YTL25680
       CLA     LINE                                                     YTL25690
       CAS     =54                                                      YTL25700
       TRA     NEWPGE        TO MMM20                                   YTL25710
       TRA     *+1                                                      YTL25720
       ADD     =1                                                       YTL25730
       STO     LINE                                                     YTL25740
       TRA     NSPCE                                                    YTL25750
KPGONG TIX     RWCELL-1,2,1  HAVE WE USED A FULL CELL OF ROW            YTL25760
```

```
       CLA     RWCELL                                                   YTL25770
       ADD     =1                                                       YTL25780
       STA     RWCELL            WANT TO USE NEXT CELL OF ROW           YTL25790
       TRA     RWCELL-2                                                 YTL25800
 STPGE NZT     SVCLPT            ARE THERE MORE THAN 10 COLUMNS         YTL25810
       TRA     NOID              NO                                     YTL25820
       CLA     =1                YES, PUT A 1 IN FLAG                   YTL25830
       STO     NCLPT                                                    YTL25840
       LXA     SVCLPT,1                                                 YTL25850
       LXA     SVCLPT,2                                                 YTL25860
       TRA     CLPT              PRINT NEW PAGE COLUMN I.D.             YTL25870
  NOID CLA     =7                COLUMN I.D. IS NOT NECESSARY           YTL25880
       STO     LINE                                                     YTL25890
       TRA     NSPCE                                                    YTL25900
       CLA     =9                RETURN FROM PRINTING COLUMN I.D.       YTL25910
       STO     LINE                                                     YTL25920
 NSPCE CLA     I                                                        YTL25930
       SUB     TESTI                                                    YTL25940
       TZE     RWIDNT            DO WE PRINT ROW IDENTIFICATION         YTL25950
       CALL    .FWRD.(.UN06.,RWPRNT)                                    YTL25960
       CALL    .FSLO.(ROW,=19)                                          YTL25970
       CALL    .FFIL.                                                   YTL25980
       TRA     TSTLMT                                                   YTL25990
RWIDNT CALL    .FWRD.(.UN06.,RWIDPT)               PRINT ROW WITH IDENT. YTL26000
       CLA     TESTI                                                    YTL26010
       TSX     .FCNV.,4                                                 YTL26020
       CALL    .FSLO.(ROW,=19)                                          YTL26030
       CALL    .FFIL.                                                   YTL26040
       CLA     TESTI                                                    YTL26050
       ADD     =10                                                      YTL26060
       STO     TESTI                                                    YTL26070
TSTLMT CLA     I                                                        YTL26080
       CAS     MA                ARE WE DONE                            YTL26090
       TRA     THRU              YES                                    YTL26100
       TRA     THRU                                                     YTL26110
       ADD     =1                NO                                     YTL26120
       STO     I                                                        YTL26130
       TRA     MRROWS                                                   YTL26140
THRU   CALL    .FWRD.(.UN06.,FINLPT)                                    YTL26150
       CALL    .FFIL.                                                   YTL26160
   OUT TRA     DONE                                                     YTL26170
*              MMM24 - UNLOAD TAPE UNIT                                 YTL26180
*              FIELD 2 = TAPE NUMBER X 10**6                            YTL26190
*              NEEDS LIBRARY ROUTINE UNLOAD                             YTL26200
 MMM24 CLA     2,4                                                      YTL26210
       SSP                                                              YTL26220
       TSX     TP,4              GET TAPE NUMBER                        YTL26230
       STO     TAPE                                                     YTL26240
       TSX     TPCK,4            IS IT A VALID NUMBER                   YTL26250
       CALL    UNLOAD(TAPE)                                             YTL26260
       TRA     DONE                                                     YTL26270
*              PACKAGE 16 MMM25                                         YTL26280
*              SQUARE ROOT OF A DIAGONAL                                YTL26290
 MMM25 TSX     CKDM1,4           CHECK DIMENSIONS IN FIELD 1            YTL26300
       TSX     CKDG1,4                                                  YTL26310
       CLA     MA                                                       YTL26320
       STA     MC                                                       YTL26330
   SR1 LDQ     NA                                                       YTL26340
       STQ     NC                                                       YTL26350
       TSX     CHKCOR,4                                                 YTL26360
       LDQ     NA                                                       YTL26370
       MPY     MA                                                       YTL26380
       XCA                                                              YTL26390
       PAX     0,4                                                      YTL26400
       STA     SR4                                                      YTL26410
       ACL     LA11                                                     YTL26420
       STA     SR5                                                      YTL26430
       PXA     0,4                                                      YTL26440
       ACL     LC11                                                     YTL26450
       ZET     ANULL                                                    YTL26460
       TRA     NMPY          A IS NULL                                  YTL26470
       STA     SR6                                                      YTL26480
   SR4 AXT     **,1          ** IS MN                                   YTL26490
   SR5 CLA     **,1          ** IS LA11+MN                              YTL26500
       STO     SQROOT                                                   YTL26510
       TZE     SR6                                                      YTL26520
       TPL     *+3                                                      YTL26530
       CLA     =12           NEGATIVE ELEMENT                           YTL26540
       TRA     MMME                                                     YTL26550
       CALL    SQRT(SQROOT)                                             YTL26560
   SR6 STO     **,1          ** IS LC11+MN                              YTL26570
       TIX     SR5,1,1                                                  YTL26580
       TTR     MMMR                                                     YTL26590
*              MMM26 - CALL IN NEW LINK OF CHAIN                        YTL26600
*                      FIELD 1 = TAPE NUMBER, MUST BE                   YTL26610
*                                1,2, OR 3                              YTL26620
*                      FIELD 4 = LINK NUMBER                            YTL26630
MMM26  TRA     DONE                                                     YTL26640
*                                                                       YTL26650
*              OPERATION CODE 27 - FIXED POINT INCREMENT                YTL26660
*              OR DECREMENT OF A SINGLE CORE LOCATION                   YTL26670
                         OR IN A CORE PROGRAM IT CAN BE                 YTL26680
                         1000 + 10I + J, WHERE I IS THE NUMBER          YTL26690
                         OF CARDS FORWARD OR BACKWARDS FROM             YTL26700
                         THIS INSTRUCTION, AND J IS THE                 YTL26710
                         FIELD WITHIN THE INSTRUCTION.IF                YTL26720
                         NEGATIVE, COUNT IS BACKWARDS.                  YTL26730
*              FIELD 1 = CORE LOCATION TO BE INCREM./DECREM.            YTL26740
*              FIELD 2 BLANK IF FIELD 4 IS THE INCREMENT                YTL26750
*              FIELD 2 NON-ZERO IF FIELD 4 IS THE INCREMENT LOCATION    YTL26760
*              FIELD 3 BLANK IF RESULT GOES INTO FIELD 1 LOCATION       YTL26770
*              OTHERWISE, RESULT GOES INTO LOCATION OF FIELD 3          YTL26780
*              FIELD 4 = NUMBER TO BE ADDED TO CONTENTS OF FIELD 1      YTL26790
*                        OR LOCATION OF NUMBER TO BE ADDED              YTL26800
*              FIELD 5 = 27                                             YTL26810
*                                                                       YTL26820
*              FIELD 3 IS NEGATIVE(OR CONTENTS IS NEGATIVE)             YTL26830
*              FOR A DECREMENT OF CELL IN FIELD 1                       YTL26840
*                                                                       YTL26850
 MMM27 CLA     FXADD                                                    YTL26860
       SLW     ADDSUB                                                   YTL26870
STRT27 CLA     YMAA                                                     YTL26880
       TSX     CHKRNG,4                                                 YTL26890
       TRA     ZROER                                                    YTL26900
       TRA     CORLOC                                                   YTL26910
       TSX     RELADR,4                                                 YTL26920
       STO     YMAA                                                     YTL26930
CORLOC CLA     YMCC                                                     YTL26940
       TZE     NOCHK3                                                   YTL26950
       TSX     CHKRNG,4                                                 YTL26960
       TRA     ZROER                                                    YTL26970
       TRA     NOCHK3                                                   YTL26980
       TSX     RELADR,4                                                 YTL26990
       STO     YMCC                                                     YTL27000
NOCHK3 CLA     YMBB                                                     YTL27010
       TNZ     USEFLD                                                   YTL27020
       CLA     YMNC                                                     YTL27030
       CAS     PROGLO                                                   YTL27040
       TRA     *+3                                                      YTL27050
       TRA     *+2                                                      YTL27060
       TRA     USEFLD                                                   YTL27070
       CLA     YMNC                                                     YTL27080
       ADD     YSHIFT                                                   YTL27090
       STO     YMNC                                                     YTL27100
       CLA*    YMNC                                                     YTL27110
       TRA     *+2                                                      YTL27120
USEFLD CLA     YMNC                                                     YTL27130
ADDSUB PZE     0                                                        YTL27140
       ADD*    YMAA                                                     YTL27150
       ZET     YMCC                                                     YTL27160
       TRA     *+3                                                      YTL27170
       STO*    YMAA                                                     YTL27180
       TRA     DONE                                                     YTL27190
       STO*    YMCC                                                     YTL27200
       TRA     DONE                                                     YTL27210
RELADR STO     SAVEF                                                    YTL27220
       CLA     KEY                                                      YTL27230
       TNZ     *+3                                                      YTL27240
       CLA     =24                                                      YTL27250
       TRA     MMME                                                     YTL27260
       CLA     SAVEF                                                    YTL27270
       SSP                                                              YTL27280
       SUB     TOPPOS                                                   YTL27290
       XCA                                                              YTL27300
       ZAC                                                              YTL27310
       DVP     =10                                                      YTL27320
       CAS     =6                                                       YTL27330
       TRA     FLDERR                                                   YTL27340
       TRA     *+1                                                      YTL27350
       STO     FLDSKP                                                   YTL27360
       MPY     =6                                                       YTL27370
       STQ     CELSKP                                                   YTL27380
       CLA     SAVEF                                                    YTL27390
       TMI     BACKSK                                                   YTL27400
       CLA     CELSKP                                                   YTL27410
       SUB     =7                                                       YTL27420
       ADD     FLDSKP                                                   YTL27430
       TRA     FINDCL                                                   YTL27440
BACKSK CLA     CELSKP                                                   YTL27450
       ADD     =7                                                       YTL27460
       SUB     FLDSKP                                                   YTL27470
       SSM                                                              YTL27480
FINDCL ADD     INST                                                     YTL27490
       TRA     1,4                                                      YTL27500
FLDERR CLA     =33                                                      YTL27510
       TRA     MMME                                                     YTL27520
*                                                                       YTL27530
*              OPERATION CODE 28 - MERGE OF MATRIX A                    YTL27540
*              AND MATRIX A+1                                           YTL27550
*                                                                       YTL27560
*                                                                       YTL27570
*                                                                       YTL27580
*              FIELD 1 =POSITION NUMBER N.  MATRIX IN                   YTL27590
*                 POSITION N+1 MERGED WITH MATRIX IN POSITION           YTL27600
*                 N.  RESULTING MATRIX IN POSITION N                    YTL27610
*                                                                       YTL27620
*              FIELD 2 =BLANK                                           YTL27630
*                                                                       YTL27640
*              FIELD 3 = BLANK                                          YTL27650
*                                                                       YTL27660
*              FIELD 4 = MAME OF MERGED MATRIX                          YTL27670
*                                                                       YTL27680
*              FIELD 5 = 28                                             YTL27690
*                                                                       YTL27700
MMM28  LDQ     MA                                                       YTL27710
       MPY     NA                                                       YTL27720
       XCA                                                              YTL27730
       ADD     LA11                                                     YTL27740
       ADD     =1            L(MB)                                      YTL27750
       STA     GETMB                                                    YTL27760
       ADD     =1            L(NB)                                      YTL27770
       STA     GETNB                                                    YTL27780
GETNB  CLA     **            NB                                         YTL27790
       STO     NB                                                       YTL27800
       SUB     NA                                                       YTL27810
       TNZ     MMMCF         COLUMN NUMBERS INCOMPATIBLE                YTL27820
GETMB  CLA     **            MB                                         YTL27830
       STO     MB                                                       YTL27840
       ADD     MA                                                       YTL27850
       STO*    MMMA          NEW NUMBER OF ROWS                         YTL27860
       XCA                                                              YTL27870
       MPY     NA                                                       YTL27880
       XCA                                                              YTL27890
       ADD     LA11                                                     YTL27900
       STA     STMA                                                     YTL27910
       TSX     CKDM12,4                                                 YTL27920
       LDQ*    GETNB                                                    YTL27930
       MPY*    GETMB                                                    YTL27940
       XCA                                                              YTL27950
       PAX     0,1           NUMBER OF WORDS TO MOVE                    YTL27960
       ADD     GETNB                                                    YTL27970
       ADD     =1                                                       YTL27980
       STA     LDMB                                                     YTL27990
       CLA     GETNB                                                    YTL28000
       ADD     =1                                                       YTL28010
       STA     *+1                                                      YTL28020
       CLA     **            LB11                                       YTL28030
       SUB     WDMNL         IS POSITION N+1 NULL                       YTL28040
       TNZ     *+3           NO                                         YTL28050
       STZ*    *-3           CLEAR OUT CODE WORD                        YTL28060
       TRA     LDMB                                                     YTL28070
       CLA     ANULL         IS POSITION N NULL, N+1 NOT NULL           YTL28080
       TZE     LDMB          NO                                         YTL28090
       STZ*    LA11          CLEAR CODE WORD WHEN POS. N NULL, N+1 NOT NYTL28100
LDMB   CLA     **,1          LB11+MB*NB                                 YTL28110
STMA   STO     Q*,1          LA11+(MA+MB)*NA                            YTL28120
       TIX     LDMB,1,1                                                 YTL28130
       AXT     3,1                                                      YTL28140
       STZ*    LDMB                                                     YTL28150
       TIX     *-1,1,1                                                  YTL28160
```

```
         CLA     YMNC                                                    YTL28170
         STO*    YMAA                                                    YTL28180
         TRA     DONE                                                    YTL28190
*                                                                        YTL28200
*                MMM29-CLEAR CORE                                        YTL28210
*                                                                        YTL28220
*                FIELD 1 IS THE STARTING ADDRESS OF CLEAR                YTL28230
*                FIELD 4 IS THE NUMBER OF LOCATIONS                      YTL28240
*                          IF ZERO,CORE IS CLEARED TO 32563              YTL28250
MMM29    CLA     YMAA                                                    YTL28260
         TSX     CHKRNG,4                                                YTL28270
         TRA     ZROER                                                   YTL28280
         TRA     *+2                                                     YTL28290
         TSX     RELADR,4                                                YTL28300
         ADD     YMNC                INCREMENT,IF ANY                    YTL28310
         CAS     HICORE                                                  YTL28320
         TRA     *+3                                                     YTL28330
         TRA     LIMOK                                                   YTL28340
         TRA     LIMOK                                                   YTL28350
         SUB     YSHIFT                                                  YTL28360
         CAS     HICORE                                                  YTL28370
         TRA     TEST2+3                                                 YTL28380
         TRA     *+1                                                     YTL28390
LIMOK    STA     ZROSRT                                                  YTL28400
         CLA     YMNC                INCREMENT                           YTL28410
         PAX     0,1                                                     YTL28420
         TZE     *+4                                                     YTL28430
         TPL     ZROSRT                                                  YTL28440
         CLA     =30                 NEGATIVE INCREMENT                  YTL28450
         TRA     MMME                                                    YTL28460
         CLA     HICORE                                                  YTL28470
         ADD     =1                                                      YTL28480
         STA     ZROSRT                                                  YTL28490
         SUB     YMAA                                                    YTL28500
         PAX     0,1                                                     YTL28510
ZROSRT   STZ     **,1                                                    YTL28520
         TIX     *-1,1,1                                                 YTL28530
         TRA     DONE                                                    YTL28540
ZROER    CLA     =29                                                     YTL28550
         TRA     MMME                                                    YTL28560
*                                                                        YTL28570
*                MMM30,MMM31,MMM32,ARE THE MULTIPLY                      YTL28580
*                AND ADD ROUTINES CORRESPONDING TO MMM6,                 YTL28590
*                MMM7,ANDMMM8.A CHECK IS MADE TO SEE                     YTL28600
*                THAT THERE IS A CONFORMABLE MATRIX IN                   YTL28610
*                THE POSITION OF FIELD 3,AND THEN IT                     YTL28620
*                TRANSFERS CONTROL TO MMM6,MMM7,OR                       YTL28630
*                MMM8. THE INITIALIZING OF THE SUMMING                   YTL28640
*                MATRIX IS LEFT UP TO THE USER                           YTL28650
*                                                                        YTL28660
 MMM30   CLA     =1                                                      YTL28670
         STO     MAD                                                     YTL28680
         CLA     MA                                                      YTL28690
         SUB*    LOCMC                                                   YTL28700
         TZE     *+3                                                     YTL28710
NCNFBS   CLA     =31                 SUMMING MATRIX NON-CONFORMABLE      YTL28720
         TRA     MMME                                                    YTL28730
         CLA     NB                                                      YTL28740
         SUB*    LOCNC                                                   YTL28750
         TNZ     NCNFBS              NON-CONFORMABLE                     YTL28760
```

```
       CLA     WDMNL                                                    YTL28770
       SUB*    LC11                                                     YTL28780
       TNZ     *+2                                                      YTL28790
       STZ     MAD                                                      YTL28800
       TRA     MMM6                                                     YTL28810
*                                                                       YTL28820
 MMM31 CLA     =1                                                       YTL28830
       STO     MAD                                                      YTL28840
       CLA     MA                                                       YTL28850
       SUB*    LOCMC                                                    YTL28860
       TNZ     NCNFBS        NON-CONFORMABLE                            YTL28870
       CLA     MB                                                       YTL28880
       SUB*    LOCNC                                                    YTL28890
       TNZ     NCNFBS        NON-CONFORMABLE                            YTL28900
       CLA     WDMNL                                                    YTL28910
       SUB*    LC11                                                     YTL28920
       TNZ     *+2                                                      YTL28930
       STZ     MAD                                                      YTL28940
       TRA     MMM7                                                     YTL28950
*                                                                       YTL28960
 MMM32 CLA     =1                                                       YTL28970
       STO     MAD                                                      YTL28980
       CLA     NA                                                       YTL28990
       SUB*    LOCMC                                                    YTL29000
       TNZ     NCNFBS        NON-CONFORMABLE                            YTL29010
       CLA     NB                                                       YTL29020
       SUB*    LOCNC                                                    YTL29030
       TNZ     NCNFBS        NON-CONFORMABLE                            YTL29040
       CLA     WDMNL                                                    YTL29050
       SUB*    LC11                                                     YTL29060
       TNZ     *+2                                                      YTL29070
       STZ     MAD                                                      YTL29080
       TRA     MMM8                                                     YTL29090
*                                                                       YTL29100
*              AS MMM 27 BUT SUB IS USED                                YTL29110
*                                                                       YTL29120
*                                                                       YTL29130
 MMM33 CLA     FXSUB                                                    YTL29140
       SLW     ADDSUB                                                   YTL29150
       TRA     STRT27                                                   YTL29160
*                                                                       YTL29170
*              FOLLOWING ARE ALL YTL01 CONSTANTS AND FORMATS            YTL29180
*                                                                       YTL29190
*                                                                       YTL29200
*              THE FOLLOWING IS A SET OF CELLS THAT                     YTL29210
*              ARE SET UP TO FACILITATE DUMPING IN                      YTL29220
*              CHARET.                                                  YTL29230
ERRCDE PZE     0             ERROR CODE                                 YTL29240
       BCI     1,ERRCDE                                                 YTL29250
  TAPE BSS     3             TAPE NO,ALSO FILE,MATRIX SPACING           YTL29260
       BCI     1,TAPE                                                   YTL29270
*              LAST INS  .        TAPE+1        .       TAPE+2          YTL29280
*                        .                      .                       YTL29290
*                 FSF    .FILE COUNT   IN DECR.            0            YTL29300
*                 BSF    .FILE COUNT -1 IN DECR..          0            YTL29310
*                 FSR    .2*MATRIX COUNT IN DECR.          0            YTL29320
*                FSF,FSR .2*MATRIX COUNT IN DECR.  FILE COUNT IN DECR   YTL29330
*                                                                       YTL29340
  SAVE BSS     16            MATRIX ID                                  YTL29350
MATID  EQU     SAVE                                                     YTL29360
```

```
       BCI     1,MATID                                                  YTL29370
KEY    PZE                                                              YTL29380
CORPRG EQU     KEY                                                      YTL29390
       BCI     1,CORPRG                                                 YTL29400
*              THESE ARE CELLS WHICH MAY BE USEFUL                      YTL29410
PHYSCT PZE     0             PHYSICAL COUNT OF INSTRUCTIONS             YTL29420
INSCNT PZE     0             COUNT OF EXECUTED INSTRUCTIONS             YTL29430
XMODE  PZE                   PARTITION ADDRESS                          YTL29440
INST   PZE                   ADDRESS OF NEXT CORE EXECUTED INSTRUCTION  YTL29450
SAVKEY PZE                                                              YTL29460
MCROCT PZE                                                              YTL29470
RETURN BSS     5                                                        YTL29480
PRGLOC BSS     5                                                        YTL29490
MA                           PARAMETERS                                 YTL29500
NA                                                                      YTL29510
LA11                                                                    YTL29520
MB                                                                      YTL29530
NB                                                                      YTL29540
LB11                                                                    YTL29550
MC                                                                      YTL29560
NC                                                                      YTL29570
LC11                                                                    YTL29580
TEMPAC PZE     0                                                        YTL29590
TEMPMQ PZE     0             SAME FOR MQ                                YTL29600
CELLO  PZE     0             SAVE OF LAST NON-ZERO CELL 0               YTL29610
*              MISCELLANEOUS CONSTANTS                                  YTL29620
WHCHFT PZE     0             FORMAT INDICATOR FOR 20                    YTL29630
TAP1IB PZE     0             TAPE NUMBER FOR TITLE IN 20 AND 23         YTL29640
TAPIB  PZE     0                                                        YTL29650
READ   BSS     8             CALLING PARAMETERS FOR OP. CODE 19         YTL29660
KRDP1  EQU     READ+1        STARTING ADDRESS                           YTL29670
KRDP4  EQU     READ+4        NUMBER 4F FIELDS                           YTL29680
KRDP5  EQU     READ+5        NUMBER OF DIGITS PER FIELD                 YTL29690
KRDP7  EQU     READ+7        TAPE NO.                                   YTL29700
TAPEIB PZE     0             TAPE UNIT SPECIFICATION FOR IOCS           YTL29710
ADRSDA PZE     DATA          ADD. FOR LOWER LIMIT OF AVAILABLE CORE     YTL29720
SEPE   PZE     0             TAPE NOTFOR LOAD PROGRAM                   YTL29730
LOC    BSS     5             THESE ARE THE 5 OPERATION FIELDS           YTL29740
TAP    PZE     0             TAPE UNIT FOR PROGRAM CARDS                YTL29750
SQROOT PZE     0             STORAGE FOR MMM25                          YTL29760
TAP1   PZE                                                              YTL29770
FPTTRA TRA     FPSPIL        TRA TO GO INTO CELL 8                      YTL29780
TMPFPT PZE     0             SAVE CELL FOR LOCATION 8                   YTL29790
XR1    PZE                   XR STORAGE FOR YTL01                       YTL29800
XR2    PZE                                                              YTL29810
XR4    PZE                                                              YTL29820
YSHIFT PZE                   RELOCATION CONSTANT                        YTL29830
IRROR  PZE                   KRD ERROR CODE FOR ALL KRD CALLS           YTL29840
INS    PZE     **,2          ADDRESS OF ERROR CODE CELLS                YTL29850
*                                                                       YTL29860
*              XR STORAGE FOR MMM                                       YTL29870
IR1    PZE                                                              YTL29880
IR2    PZE                                                              YTL29890
IR3    PZE     0                                                        YTL29900
IR4    PZE                                                              YTL29910
IR5    PZE     0                                                        YTL29920
IR6    PZE     0                                                        YTL29930
IR7    PZE     0                                                        YTL29940
PARTON OCT     777777777777  SET TO ZERO AFTER A PARTITION IS FORMED    YTL29950
FIRST  PZE     1                                                        YTL29960
```

```
*              CONSTANTS FOR VARIOUS DIAGNOSTICS                           YTL29970
PROGLO PZE                     LOWEST CORELOC. FROM CARDS NORMALLY 8000    YTL29980
SMLTAP DEC     1000000         SMALLEST TAPE NUMBER                        YTL29990
LOCORE PZE                     LOWEST LEGAL CORE ADDRESS                   YTL30000
HICORE PZE                     HIGEST POSSIBLE CORE ADDRESS                YTL30010
TOPPOS PZE     1000            LARGER THAN ANY LEGAL POSITION NUMBER       YTL30020
MXDATA PZE                     MAXIMUM SIZE OF ANY MATRIX                  YTL30030
HIP-OG PZE                     MAXIMUM LOAD ADDRESS OF A PROGRAM           YTL30040
TSTMAC EQU     7999            TEST CONSTANT FOR MACRO INSTRUCTION         YTL30050
MXTAPS EQU     19              MAXIMUM NUMBER OF TAPES                     YTL30060
*              THESE TWO CONSTANTS ARE EQUATED TO ABOVE ONES.              YTL30070
*              AND MUSTBE PRESERVED IF SMLTAP,TOPPOS,CHANGE                YTL30080
*                                                                          YTL30090
THOUSN EQU     TOPPOS          MUST BE 1000(DECIMAL)                       YTL30100
MILYN  EQU     SMLTAP          MUST BE 1000000(DECIMAL)                    YTL30110
*                                                                          YTL30120
 SIGN  PZE                     SET TO NON-ZERO IF 32564 HAS BEEN STUFFED   YTL30130
COREND BCI     1,COREND        CODE WORD PUT IN 32564                      YTL30140
*              XR4 STORAGE FOR MMM90                                       YTL30150
 SPOT4                                                                     YTL30160
*              PARAMATERS FOR 3 WORKING MATRICES                           YTL30170
*              CELLS FOR READ/WRITE BINARY TAPE                            YTL30180
 MTN   PZE                     M*N                                         YTL30190
 TESTC PZE                     TEMPORARY                                   YTL30200
 WDMNL BCI     1,M=NULL                                                    YTL30210
SPARSE BCI     1,SPARSE                                                    YTL30220
SPMTC1 PZE                     TEST CELL FOR SPARSE MATRIX                 YTL30230
*      WDWC IS THE NUMBER OF ELEMENTS AND CONTROL                          YTL30240
*      WORDS NEEDED TO WRITE A SPARSE MATRIX. NEEDED                       YTL30250
*      TO INSURE A MINIMUM RECORD ON TAPE OF 16 WORDS.                     YTL30260
 WDWC  PZE                                                                 YTL30270
 MNP3  PZE                     M*N+3 +LA11                                 YTL30280
RSCKSM PZE                     USED FOR SPARSE CHECKSUM TEMP               YTL30290
READTP PZE                     TEMP FOR WORD FROM TAPE IN SPARSE READ      YTL30300
 ERR   PZE                     ERROR CODE FOR BSF,FSR,FSF                  YTL30310
*              4 TEMPORARY STORAGE CELLS                                   YTL30320
       BSS     3                                                           YTL30330
 TEMP  PZE                                                                 YTL30340
*              NULL MATRIX COTEMP AC FORFPT ANALYSIS                       YTL30350
 ANULL                                                                     YTL30360
 BNULL                                                                     YTL30370
 FILL5 CLA     0,1                                                         YTL30380
 FILL6 CLS     0,1                                                         YTL30390
 FILL7 CLA     =Q                                                          YTL30400
*                                                                          YTL30410
 FILL0 NOP                     FOR MATRIX MOVE                             YTL30420
 FILL1 FAD 0,1                 FOR MMM1                                    YTL30430
 FILL2 FSB 0,1                 FOR MMM2                                    YTL30440
 FILL3 FAD 0,2                 FOR MMM3                                    YTL30450
 FILL4 FSB 0,2                 FOR MMM4                                    YTL30460
DOTPRD BSS     3               CELLS USED FOR DOUBLE PRECISION             YTL30470
*                              DOT PRODUCT - NEED 3 TO INSURE              YTL30480
*                              AN EVEN LOCATION ALWAYS                     YTL30490
  TOTA PZE     0               MA * NA                                     YTL30500
  TOTB PZE     0               MB*NB                                       YTL30510
INCRMA PZE     0               STORAGE INCREMENT FOR A                     YTL30520
INCRMB PZE     0               STORAGE INCREMENT FOR B                     YTL30530
MADYES FAD*    ANSWER          USED FOR MMM30,31,32                        YTL30540
MADNO  TRA     ANSWER-1        USED FOR MMM6,7,8                           YTL30550
 FIL10 FAD 0,2                 FOR MMM10                                   YTL30560
 FIL11 FSB 0,2                  FOR MMM11                                    YTL30570
*               CONSTANT STORAGE FOR MMM18                                   YTL30580
  IRR1 PZE      0               ERROR CODE 1                                 YTL30590
  IRR2 PZE      0               ERROR CODE 2                                 YTL30600
 SCALE PZE      0               CELL FOR SCALE FACTOR                        YTL30610
   DET PZE      0               FRACTIONAL PART OF DETERMINANT               YTL30620
       PZE      0                                                            YTL30630
NDETXP PZE      0               EXPONENT PART OF DETERMINANT                 YTL30640
   NSQ PZE      0               N**2                                         YTL30650
TWONSQ PZE      0               2*N**2                                       YTL30660
*               MMM20 CONSTANTS                                              YTL30670
 TITLE BSS      14              TITLE STORAGE                                YTL30680
CHKSUM PZE      0               PRINT CHECKSUM                               YTL30690
  LINE PZE      0               LINE COUNT                                   YTL30700
 SPACE PZE      0               TEST CELL FOR INITIAL SPACING TO NEW PAGE    YTL30710
  TTLE PZE      0               FIELD 4 INDICATOR                            YTL30720
   MAP PZE      0               TEST CELL FOR MAP ROUTINE                    YTL30730
     I PZE      0               ROW COUNT                                    YTL30740
 CELL1 PZE      0               SCRATCH FOR MMM22                            YTL30750
*               MMM23 CONSTANTS                                              YTL30760
 LEVEL PZE      0               FL.PT. NUMBER FOR TESTING                    YTL30770
 TESTI PZE      0               COUNT FOR FINDING EVERY 10TH ROW             YTL30780
  ROW  BSS      19              STORAGE FOR 1 PRINTED ROW                    YTL30790
SVCLPT PZE      0               COUNT FOR COLUMN ID                          YTL30800
 NCLPT PZE      0               FLAG FOR NEW PAGE COLUMN HEADING             YTL30810
*               MAP PARAMETERS                                               YTL30820
  ZERO OCT      007777777777                                                 YTL30830
       OCT      770077777777                                                 YTL30840
       OCT      777700777777                                                 YTL30850
       OCT      777777007777                                                 YTL30860
       OCT      777777770077                                                 YTL30870
       OCT      777777777700                                                 YTL30880
DOLSGN OCT      530000000000                                                 YTL30890
       OCT      005300000000                                                 YTL30900
       OCT      000053000000                                                 YTL30910
       OCT      000000530000                                                 YTL30920
       OCT      000000005300                                                 YTL30930
       OCT      000000000053                                                 YTL30940
 POINT OCT      330000000000                                                 YTL30950
       OCT      003300000000                                                 YTL30960
       OCT      000033000000                                                 YTL30970
       OCT      000000330000                                                 YTL30980
       OCT      000000003300                                                 YTL30990
       OCT      000000000033                                                 YTL31000
FLDSKP PZE      0               COUNT OF FIELDS -MMM27                       YTL31010
CELSKP PZE      0               COUNT OF CELLS FOR CARDS TO SKIP             YTL31020
SAVEF  PZE      0                                                            YTL31030
FXSUB  CHS                                                                   YTL31040
FXADD  TRA      ADDSUB+1                                                     YTL31050
   MAD PZE      0               TEST CELL FOR MMM30,31,32                    YTL31060
SAVINS PZE                                                                   YTL31070
*               NON ZERO FOR 30,31,32,OTHERWISE 0                            YTL31080
*                                                                            YTL31090
*               FORMAT FOR ERROR PRINT IN CONTROL SECTION                    YTL31100
CORERR BCI      8,(1H ,10X,51HUNABLE TO PRINT CURRENT CORE PROGRAM           YTL31110
       BCI      4, - ERROR CODE = I10)                                       YTL31120
ERRPNT BCI      7,(1H1,10X,43HAN ERROR HAS OCCURRED IN TL-01                 YTL31130
       BCI      7, - THE CODE = I10/1H0,9X,11HA TOTAL OF I6,                 YTL31140
       BCI      7,60H INSTRUCTIONS WERE SUCCESSFULLY EXECUTE                 YTL31150
       BCI      5,D PRIOR TO THE ERROR./1H )                                 YTL31160
```

```
PROGER BCI     6,(11X,58HTHE ABOVE COUNT WAS STARTED                          YTL31170
       BCI     6,WITH THE CORE PR-GRAM BELOW.  /1H0,                          YTL31180
       BCI     6,10X,49HTHE ERROR OCCURRED AT PHYSICA                         YTL31190
       BCI     5,L INSTRUCTION NUMBER I6/1H0)                                 YTL31200
*                                                                             YTL31210
*              INVERSION FORMATS                                              YTL31220
INVFMT BCI     9,(1H1,10X,26HINVERSION ERROR - CODE1 = I5,9H CODE2 =          YTL31230
       BCI     5,I5,16H SCALE FACTOR = E18.8)                                 YTL31240
DETPNT BCI     9,(1H1/1H0/1H0,4X,4HTHE I5,4H BY I5,15H MATRIX NUMBER          YTL31250
       BCI     6,I12,22H HAS A DETERMINANT OF F10.7,                          YTL31260
       BCI     6,17H TIMES 10 TO THE I12,7H POWER.)                           YTL31270
*                                                                             YTL31280
*              MMM20 FORMATS                                                  YTL31290
*                                                                             YTL31300
NPAGE  BCI     3,(1H1/1H0/1H )                                                YTL31310
TLEIN  BCI     2,(13A6,A2)                                                    YTL31320
TLEOUT BCI     4,(1H ,10X,13A6,A2/1H )                                        YTL31330
MATNO  BCI     6,(1H ,10X,14HMATRIX NUMBER I11/1H )                           YTL31340
ORDSUM BCI     6,(1H ,10X,6HORDER I4,4H BY I4/1H0,10X                         YTL31350
       BCI     4,,12HCHECK SUM = O12/1H )                                     YTL31360
NWPGE1 BCI     6,(1H1/1H0,10X,14HMATRIX NUMBER I11/1H                         YTL31370
       BCI     1,0/1H )                                                       YTL31380
NWPGE2 BCI     5,(1H1/1H0,10X,13A6,A2/1H0/1H )                                YTL31390
FINAL  BCI     6,(1H0/1H0,10X,20HEND OF MATRIX PRINT.                         YTL31400
       BCI     2,/1H0/1H0)                                                    YTL31410
INTPNT BCI     6,(1H0,4X,I4,2X,6(I12,1HB,3X),I12,1HB/                         YTL31420
       BCI     7,(          I23,1HB,3X,I12,1HB,3X,I12,1HB,3X,                 YTL31430
       BCI     7,I12,1HB,3X,I12,1HB,3X,I12,1HB,3X,I12,1HB))                   YTL31440
FLPPNT BCI     6,(1H0,4X,I4,2X,6(1PE13.6,3X),E13.6/(                          YTL31450
       BCI     4,        E24.6,6E16.6))                                       YTL31460
CSMPT  BCI     8,(1H0/1H0,10X,24HREQUESTED CHECKSUM ONLY./1H0                 YTL31470
       BCI     1,/1H0)                                                        YTL31480
NULMAT BCI     6,(1H ,10X,18HTHE MATRIX IS NULL)                              YTL31490
*              MMM23 FORMATS                                                  YTL31500
*                                                                             YTL31510
LVLPT  BCI     7,(11X,53HMATRIX ELEMENTS WITH MAGNITUDE LES                   YTL31520
       BCI     6,S THAN OR EQUAL TO 1PE16.6,31H ARE M                         YTL31530
       BCI     5,APPED AS A DECIMAL POINT./1H )                               YTL31540
COLPT  BCI     4,(1H ,16X,I3,10(7X,I3))                                       YTL31550
COLPT1 BCI     4,(1H ,18X,A1,10(9X,A1))                                       YTL31560
RWPRNT BCI     3,(1H ,9X,18A6,A2)                                             YTL31570
RWIDPT BCI     4,(1H ,5X,I3,1H+,18A6,A2)                                      YTL31580
FINLPT BCI     8,(1H0/1H0,10X,18HEND OF MATRIX MAP./1H0/1H0)                  YTL31590
*                                                                             YTL31600
       END                                                                    YTL99990
```

SUBROUTINE INV4DS

```
$IBMAP INVERT  650,DECK,M94/2                                           INV00000
*INV4DS        7094 DOUBLE PRECISION INVERSION ROUTINE                  INV00010
*                                                                       INV00020
*              CALL INV4DS,A,N,ERR1,ERR2,SCALE,DET,NDETXP               INV00030
*                   A = STARTING ADDRESS OF MATRIX - MUST BE EVEN       INV00040
*                   N = NUMBER OF ROWS (COLUMNS) OF MATRIX              INV00050
*                       IF NEGATIVE, PIVOT TERMS ARE PRINTED            INV00060
*                ERR1 = 0 IF INVERSION SUCCESSFUL                       INV00070
*                     = 1 IF OVERFLOW OCCURS                            INV00080
*                     = 2 IF MATRIX IS SINGULAR                         INV00090
*                     = 3 IF SCALED INVERSE CANNOT BE RE-SCALED         INV00100
*                     = 4 IF ROWS AND COLUMNS CANNOT BE RE-ARRANGED     INV00110
*                         THIS IS BASICALLY A MACHINE ERROR             INV00120
*                     = 5 IF (1,1) ELEMENT IS IN AN ODD LOCATION        INV00130
*                     = 6  IF ODD STORAGE TRAP DURING REDUCTION         INV00140
*                          THIS MUST BE A MACHINE ERROR                 INV00150
*                     = 10 + I IF ERROR CODE 3 OCCURED SUBSEQUENT       INV00160
*                              TO ERROR CODE I                          INV00170
*                     = 20 + I IF ERROR CODE 4 OCCURED SUBSEQUENT       INV00180
*                              TO ERROR CODE I                          INV00190
*                ERR2 = CURRENT REDUCTION STAGE IF ERR1=1               INV00200
*                     = RANK OF MATRIX IF ERR1 =2                       INV00210
*                     = 0 OTHERWISE                                     INV00220
*               SCALE = 0 IF ERR1 NOT = 3                               INV00230
*                     = SCALING FACTOR IF ERR1=3                        INV00240
*                 DET= DECIMAL PART OF DETERMINANT IF ERR1.             INV00250
*                       NOT = 2 - A NUMBER GT OR E TO 1. AND LT 10.     INV00260
*                     = 0 IF ERR1=2                                     INV00270
*               DETXP = EXPONENT PART OF DETERMINANT IF ERR1            INV00280
*                       NOT = 2 - AN ADDRESS INTEGER GIVING             INV00290
*                       POWER OF TEN FOR DETERMINANT                    INV00300
*                       DETERMINANT = DET*10.**DETXP                    INV00310
       ENTRY   INV4DS                                                   INV00320
*                                                                       INV00330
*              SET UP CONSTANTS AND INITIALIZE CELLS                    INV00340
*                                                                       INV00350
INV4DS LMTM                                                             INV00360
       EFTM                                                             INV00370
       SXA     XR1,1                                                    INV00380
       SXA     XR2,2                                                    INV00390
       SXA     XR3,3                                                    INV00400
       SXA     XR4,4                                                    INV00410
       SXA     XR5,5                                                    INV00420
       SXA     XR6,6                                                    INV00430
       SXA     XR7,7                                                    INV00440
       STZ     0             CLEAR CELL 0 FOR FPT                       INV00450
       STZ     CHRCNG        CLEAR CELL FOR CHARACTERISTIC SCALING      INV00460
       STZ     ERRCD1        CLEAR ERROR CODE CELLS                     INV00470
       STZ     ERRCD2                                                   INV00480
       CAL     8             SAVE CELL 8 FOR (FPT)                      INV00490
       SLW     TEMP8                                                    INV00500
       CAL     FPTTRA        STORE TRANSFER FOR FPT ANALYSIS.           INV00510
       SLW     8                                                        INV00520
       STZ*    7,4           ZERO SCALING CELL                          INV00530
       STZ     DETXP         ZERO DETERMINANT EXPONENT                  INV00540
       CLA*    4,4                                                      INV00550
       STO     PRINT         SET INDICATOR FOR PRINT                    INV00560
       SSP                                                              INV00570
       XCA                                                              INV00580
       STQ     N                                                        INV00590
       MPY     N                                                        INV00600
       XCA                                                              INV00610
       ALS     1                                                        INV00620
       STO     TWONSQ          2*N**2                                   INV00630
       ACL     3,4                                                      INV00640
       STA     AP2NSQ          A+2*N**2                                 INV00650
       ACL     N                                                        INV00660
       STA     ADRINT          ADDRESS OF ROW INTEGERS +N               INV00670
       ACL     N                                                        INV00680
       STA     ADCINT          ADDRESS OF COLUMN INTEGERS +N            INV00690
       STA     MULTPL          ADDRESS OF REDUCTION FACTOR              INV00700
       ADD     =2                                                       INV00710
       STA     DET             ADDRESS OF DETERMINANT                   INV00720
       ADD     =1                                                       INV00730
       STA     DETP1           ADDRESS OF DETERMINANT LEAST SIG.        INV00740
       ADD     =1                                                       INV00750
       STA     TEN             ADDRESS OF FLOATING POINT 10             INV00760
       CLA     3,4                                                      INV00770
       LBT                     TEST TO SEE IF STORAGE IS EVEN           INV00780
       TRA     *+2             EVEN STORAGE                             INV00790
       TRA     ERR5            ODD STORAGE - ERROR                      INV00800
       STA     ADA             ADDRESS OF A                             INV00810
       STA     ADPVEL          ADDRESS OF CURRENT PIVOT ELEMENT         INV00820
       ACL     N                                                        INV00830
       ACL     N                                                        INV00840
       STA     ADPVRW          ADDRESS OF CURRENT PIVOT ROW + 2*N       INV00850
       SUB     ADA                                                      INV00860
       STA     TWON            2*N                                      INV00870
       PAX     0,1                                                      INV00880
       SXD     REDUC4,1        STUFF LOOP CONTROL FOR REDUCE            INV00890
       CLA     =1.                                                      INV00900
       LDQ     =0                                                       INV00910
       DST*    DET             START DET OFF AT 1.                      INV00920
       CLA     =10.                                                     INV00930
       DST*    TEN             LOAD 10 IN DOUBLE PRECISION CELL         INV00940
       CLA     PRINT                                                    INV00950
       TPL     NPRNT1                                                   INV00960
       CALL    .FWRD.(.UN06.,TITLE)                                     INV00970
NPRNT1 LXA     N,7                                                      INV00980
       SXD     RDLPED,7        TEST AT END OF REDUCTION LOOP            INV00990
       SXD     STOINT,7        PUT INTEGERS INTO ROW AND COLUMN         INV01000
       PXA     0,0                                                      INV01010
       AXT     1,1             INTERCHANGE ARRAYS                       INV01020
       PXA     0,1                                                      INV01030
       STO*    ADCINT          ADCINT HAS A TAG OF 1                    INV01040
       STO*    ADRINT          ADRINT HAS A TAG OF 1                    INV01050
       TXI     *+1,1,1         INTEGERS ARE STORRED BACKWARDS           INV01060
STOINT TXL     *-4,1,**        N IN DECREMENT                           INV01070
*                                                                       INV01080
*              START OF REDUCTION LOOP                                  INV01090
*              REDUCTION STAGE IS KEPT IN XR1                           INV01100
*              AT THE END OF THIS LOOP ALL INVERSION                    INV01110
*                 ARITHMETIC IS DONE                                    INV01120
*                                                                       INV01130
       AXT     1,1             INITIALIZE REDUCTION STAGE               INV01140
RDLPST TSX     FINDLE,4        FIND LARGEST ELEMENT IN N-XR1+1 SUB MATRIX INV01150
       SXA     TEMPXR,1                                                 INV01160
       PXA    0,1                                                       INV01170
       SUB    LGSTRW                                                    INV01180
       TZE    COLTST                                                    INV01190
       CLA*   DET                                                       INV01200
       CHS                                                              INV01210
       STO*   DET                                                       INV01220
       TSX    INRCHR,4                                                  INV01230
       TSX    TEMPXR                                                    INV01240
       TSX    LGSTRW                                                    INV01250
       CLA    ADRINT                                                    INV01260
       SUB    LGSTRW                                                    INV01270
       STA    *+2                                                       INV01280
       STA    *+3                                                       INV01290
       CLA    **                                                        INV01300
       LDQ*   ADRINT                                                    INV01310
       STQ    **                                                        INV01320
       STO*   ADRINT                                                    INV01330
COLTST PXA    0,1                                                       INV01340
       SUB    LGSTCL                                                    INV01350
       TZE    PRNTPV                                                    INV01360
       CLA*   DET                                                       INV01370
       CHS                                                              INV01380
       STO*   DET                                                       INV01390
       TSX    INRCHC,4                                                  INV01400
       TSX    TEMPXR                                                    INV01410
       TSX    LGSTCL                                                    INV01420
       CLA    ADCINT                                                    INV01430
       SUB    LGSTCL                                                    INV01440
       STA    *+2                                                       INV01450
       STA    *+3                                                       INV01460
       CLA    **                                                        INV01470
       LDQ*   ADCINT                                                    INV01480
       STQ    **                                                        INV01490
       STO*   ADCINT                                                    INV01500
PRNTPV CLA    PRINT                                                     INV01510
       TPL    STRTSC                                                    INV01520
       LFTM                                                             INV01530
       PXA    0,1                                                       INV01540
       TSX    .FCNV.,4                                                  INV01550
       CLS    CHRCNG                                                    INV01560
       ADM*   ADPVEL                                                    INV01570
       LDQ    ADPVEL                                                    INV01580
       LLS    0                                                         INV01590
       TSX    .FCNV.,4                                                  INV01600
       CLA*   ADRINT                                                    INV01610
       TSX    .FCNV.,4                                                  INV01620
       CLA*   ADCINT                                                    INV01630
       TSX    .FCNV.,4                                                  INV01640
       EFTM                                                             INV01650
*                                                                       INV01660
*                                                                       INV01670
STRTSC TXH    SCLOOP+1,1,1                                              INV01680
       CAL*   ADPVEL        LARGEST ELEMENT = PIVOT ELEMENT             INV01690
       ANA    =0377000000000   MASK OUT ALL BUT CHARACTERISTIC          INV01700
       SUB    =0177000000000   FIND DIFFERENCE FROM 177                 INV01710
       CHS                                                              INV01720
       STO    CHRCNG        SAVE CHARACTERISTIC SCALING                 INV01730
       TZE    SCLOOP+1      BY-PASS SCALING IF NOT NEEDED               INV01740
       LXA    TWONSQ,7                                                  INV01750
FSTSCL NZT*   AP2NSQ        AP2NSQ HAS A TAG OF 7                       INV01760
```

```
       TRA     SCLOOP            NUMBER IS ZERO, DO NOT SCALE            INV01770
       CLA     CHRCNG            SCALE NUMBER                            INV01780
       ADM*    AP2NSQ                                                    INV01790
       TPL     *+3                                                       INV01800
       STZ*    AP2NSQ            IF NEGATIVE, UNDERFLOW OCCURRED         INV01810
       TRA     SCLOOP                                                    INV01820
       LDQ*    AP2NSQ            SCALING SUCCESSFUL, RESTORE SIGN        INV01830
       LLS     0                                                         INV01840
       STO*    AP2NSQ            STORE IN ORIGINAL LOCATION              INV01850
SCLOOP TIX     FSTSCL,7,1        END OF SCALING LOOP                     INV01860
       TSX     REDUCE,4          PERFORM CURRENT REDUCTION STAGE         INV01870
       DLD*    ADPVEL                                                    INV01880
       TSX     SCALE,4           SCALE PIVOT ELEMENT                     INV01890
       DFMP*   DET                                                       INV01900
       TSX     SCALE,4           SCALE PRODUCT                           INV01910
       DST*    DET               RUNNING PRODUCT OF PIVOT ELEMENTS       INV01920
       LXA     TWON,7                                                    INV01930
       DLD*    ADPVEL                                                    INV01940
       DST*    MULTPL            KEEP PIVOT ELEMENT TEMP. IN MULTPL      INV01950
ADJUST DLD*    ADPVRW            ADPVRW HAS TAG OF 7                     INV01960
       DFDP*   MULTPL                                                    INV01970
       DST*    ADPVRW            DIVIDE PIVOT ROW BY PIVOT ELEMENT       INV01980
       TIX     ADJUST,7,2                                                INV01990
       CLA     =1.                                                       INV02000
       LDQ     =0                                                        INV02010
       DFDP*   MULTPL                                                    INV02020
       DST*    ADPVEL            PUT 1/(PIV. ELEM) INTO PIVOT POSITION   INV02030
       TXI     *+1,1,1           INCREMENT TO NEW REDUCTION STAGE        INV02040
RDLPED TXH     REDOVR,1,**       N IN DECREMENT-LOOP EXIT                INV02050
       CLA     ADPVEL                                                    INV02060
       ADD     =2                                                        INV02070
       ADD     TWON                                                      INV02080
       STA     ADPVEL            INCREMENT BY 2*N+2                      INV02090
       CLA     ADPVRW                                                    INV02100
       ADD     TWON                                                      INV02110
       STA     ADPVRW            INCREMENT BY 2*N                        INV02120
       TRA     RDLPST            ANOTHER REDUCTION STAGE                 INV02130
*                                                                        INV02140
*              ALL ARITHMETIC IS OVER NOW REARANGE ROWS                  INV02150
*              AND COLUMNS                                               INV02160
*                                                                        INV02170
*              FIRST, INTERCHANGE COLUMNS ACCORDING TO ROW TABLE         INV02180
*                                                                        INV02190
REDOVR LXA     N,7                                                       INV02200
       STZ     TEMP1             CLEAR FOR XR USE                        INV02210
       PXA     0,7                                                       INV02220
       PAX     0,1                                                       INV02230
RWSRCH PXA     0,7                                                       INV02240
       SUB*    ADRINT            ADRINT HAS A TAG OF 1                   INV02250
       TZE     FOUNDR                                                    INV02260
       TIX     RWSRCH,1,1                                                INV02270
       TRA     ERR4                                                      INV02280
FOUNDR PXA     0,7                                                       INV02290
       SXA     TEMP1,1                                                   INV02300
       SUB     TEMP1                                                     INV02310
       TZE     RWLPED            COLUMN IS IN CORRECT PLACE              INV02320
       SXA     TEMPXR,7                                                  INV02330
       TSX     INRCHC,4                                                  INV02340
       TSX     TEMPXR            ROW INTEGER FOUND                       INV02350
       TSX     TEMP1             LOCATION OF ROW INTEGER                 INV02360
```

```
*             INTERCHANGE ROW INTEGERS.                                 INV02370
       LXA    TEMPXR,7                                                  INV02380
       CLA    ADRINT                                                    INV02390
       SUB    TEMPXR                                                    INV02400
       STA    *+1                                                       INV02410
       CLA    **                                                        INV02420
       STO*   ADRINT        ADRINT HAS A TAG OF 1                       INV02430
       CLA    TEMPXR                                                    INV02440
       STO*   *-3                                                       INV02450
RWLPED TIX    RWSRCH-2,7,1  LOOP FOR N ROWS.                            INV02460
*                                                                       INV02470
*             NOW INTERCHANCE ROWS ACCORDING TO COLUMN TABLE            INV02480
*                                                                       INV02490
       LXA    N,7                                                       INV02500
       PXA    0,7                                                       INV02510
       PAX    0,1                                                       INV02520
CLSRCH PXA    0,7                                                       INV02530
       SUB*   ADCINT        ADCINT HAS A TAG OF 1                       INV02540
       TZE    FOUNDC                                                    INV02550
       TIX    CLSRCH,1,1                                                INV02560
       TRA    ERR4                                                      INV02570
FOUNDC PXA    0,7                                                       INV02580
       SXA    TEMP1,1                                                   INV02590
       SUB    TEMP1                                                     INV02600
       TZE    CLLPED        ROW IS IN CORRECT PLACE                     INV02610
       SXA    TEMPXR,7                                                  INV02620
       TSX    INRCHR,4                                                  INV02630
       TSX    TEMPXR                                                    INV02640
       TSX    TEMP1                                                     INV02650
*             INTERCHANGE COLUMN INTEGERS                               INV02660
       LXA    TEMPXR,7                                                  INV02670
       CLA    ADCINT                                                    INV02680
       SUB    TEMPXR                                                    INV02690
       STA    *+1                                                       INV02700
       CLA    **                                                        INV02710
       STO*   ADCINT        ADCINT HAS A TAG OF 1                       INV02720
       CLA    TEMPXR                                                    INV02730
       STO*   *-3                                                       INV02740
CLLPED TIX    CLSRCH-2,7,1  LOOP FOR N COLUMNS                          INV02750
*                                                                       INV02760
*             INVERSE IS NOW IN THE CORRECT FORM - TIME TO              INV02770
*             RESCALE THE SCALED INVERSE                                INV02780
*                                                                       INV02790
       CLA    CHRCNG                                                    INV02800
       TZE    DSLPED+1        IF CHRCNG=0, RESCALING UNNECESSARY        INV02810
       TMI    RESCAL          IF NEGATIVE, NO OVERFLOW PROBLEMS         INV02820
       AXT    1,1             SET UP XR1 FOR FINDLE                     INV02830
       CLA    ADA             SET UP TO PIVOT ROW 1 FOR FINDLE          INV02840
       ADD    TWON                                                      INV02850
       STA    ADPVRW                                                    INV02860
       TSX    FINDLE,4        FIND LARGEST ELEMENT IN SCALED INVERSE    INV02870
       CLA    CHRCNG                                                    INV02880
       ADM    TEMP1           FINDLE STORES LARGEST IN TEMP1            INV02890
       PBT                    WAS THERE OVERFLOW                        INV02900
       TRA    *+2             NO                                        INV02910
       TRA    ERR3            YES                                       INV02920
RESCAL LXA    TWONSQ,7                                                  INV02930
       CLA    CHRCNG                                                    INV02940
       ADM*   AP2NSQ          AP2NSQ HAS A TAG OF 7                     INV02950
       ZET*   AP2NSQ                                                    INV02960
       TPL    *+3              NO UNDERFLOW IF POSITIVE                  INV02970
       STZ*   AP2NSQ           UNDERFLOW, STORE ZERO                     INV02980
       TRA    RSCLED                                                     INV02990
       LDQ*   AP2NSQ                                                     INV03000
       LLS    0                                                          INV03010
       STO*   AP2NSQ                                                     INV03020
RSCLED TIX    RESCAL+1,7,1     LOOP FOR 2*N**2 NUMBERS                   INV03030
*                                                                        INV03040
*             NOW RESCALE THE DETERMINANT                                INV03050
*                                                                        INV03060
       NZT*   DET              IS MATRIX SINGULAR                        INV03070
       TRA    DSLPED+1         IF SINGULAR, RETURN                       INV03080
       CLA    CHRCNG                                                     INV03090
       CHS                                                               INV03100
       STO    CHRCNG                                                     INV03110
       LXA    N,7                                                        INV03120
STDSCL CLA    CHRCNG                                                     INV03130
       ADM*   DET                                                        INV03140
       PBT                                                               INV03150
       TRA    *+2              NO OVERFLOW                               INV03160
       TRA    DIVDET           OVERFLOW, DIVIDE BY 10                    INV03170
       TMI    MLTDET           UNDERFLOW, MULTIPLY BY 10                 INV03180
       LDQ*   DET                                                        INV03190
       LLS    0                                                          INV03200
       STO*   DET                                                        INV03210
       CLA    CHRCNG           SCALE LEAST HALF                          INV03220
       ADM*   DETP1                                                      INV03230
       TPL    *+2              POSITIVE IF NO UNDERFLOW                  INV03240
       PXA    0,0              ZERO LEAST HALF IF UNDERFLOW              INV03250
       LLS    0                RESTORE SIGN TO LEAST HALF                INV03260
       STO*   DETP1                                                      INV03270
       DLD*   DET                                                        INV03280
       TSX    SCALE,4                                                    INV03290
       DST*   DET                                                        INV03300
       TRA    DSLPED           GO TO END OF LOOP                         INV03310
DIVDET DLD*   DET              DIVIDE DET BY TEN                         INV03320
       DFDP*  TEN                                                        INV03330
       DST*   DET                                                        INV03340
       TRA    STDSCL                                                     INV03350
MLTDET DLD*   DET              MULTIPLY DET BY TEN                       INV03360
       DFMP*  TEN                                                        INV03370
       DST*   DET                                                        INV03380
       TRA    STDSCL                                                     INV03390
DSLPED TIX    STDSCL,7,1       LOOP N TIMES FOR COMPLETE SCALING         INV03400
*                                                                        INV03410
*             END OF ALL ARITHMETIC NOW TIME TO ARRANGE                  INV03420
*             ERROR CODES AND SUCH THEN RETURN                           INV03430
       CLA    PRINT            DID WE P-INT                              INV03440
       TPL    XR1                                                        INV03450
       CALL   .FFIL.                                                     INV03460
   XR1 AXT    **,1                                                       INV03470
   XR2 AXT    **,2                                                       INV03480
   XR3 AXT    **,3                                                       INV03490
   XR4 AXT    **,4                                                       INV03500
   XR5 AXT    **,5                                                       INV03510
   XR6 AXT    **,6                                                       INV03520
   XR7 AXT    **,7                                                       INV03530
       CAL    TEMP8            RESTORE CELL 8                            INV03540
       SLW    8                                                          INV03550
       DLD*   DET                                                        INV03560
       DST*    8,4                                                     INV03570
       CLA     DETXP                                                   INV03580
       STO*    9,4                                                     INV03590
       CLA     ERRCD1                                                  INV03600
       STO*    5,4                                                     INV03610
       CLA     ERRCD2                                                  INV03620
       STO*    6,4                                                     INV03630
       TRA     10,4                                                    INV03640
*                                                                      INV03650
*              FOLLOWING ARE ALL THE ERROR STOPS                       INV03660
*                                                                      INV03670
  ERR1 CLA     =1            OVERFLOW RETURN                           INV03680
       STO     ERRCD1                                                  INV03690
       SXA     ERRCD2,1      SAVE REDUCTION STAGE                      INV03700
       STZ*    DET           ZERO DETERMINANT                          INV03710
       STZ*    DETP1                                                   INV03720
       STZ     DETXP                                                   INV03730
       TRA     REDOVR        TRANSFER BACK TO INTERCHANGE ROWS         INV03740
*                            AND COLUMNS, AND RESCALE                  INV03750
  ERR2 CLA     =2                                                      INV03760
       STO     ERRCD1                                                  INV03770
       PXA     0,1                                                     INV03780
       SUB     =1                                                      INV03790
       STO     ERRCD2        RANK OF MATRIX =XR1-1                     INV03800
       TRA     ERR1+3        TRANSFER BACK TO INTERCHANGE              INV03810
*                            ROWS AND COLUMNS, AND RESCALE             INV03820
  ERR3 CLA     ERRCD1                                                  INV03830
       TNZ     ERR3PL                                                  INV03840
       CLA     =3                                                      INV03850
       STO     ERRCD1                                                  INV03860
       CLA     =1.           =0201400000000                            INV03870
       ADD     CHRCNG                                                  INV03880
       LXA     XR4,4                                                   INV03890
       STO*    7,4           STORE SCALING FACTOR                      INV03900
       TRA     RSCLED+1      GO BACK AND SCALE DETERMINANT             INV03910
  ERR4 CLA     ERRCD1        CANNOT RE-ARRANGE ROWS,COLUMNS -MACH. ERRORINV03920
       TNZ     ERR4PL                                                  INV03930
       CLA     =4                                                      INV03940
       STO     ERRCD1        CANNOT RE-ORDER ROWS AND COLUMNS          INV03950
       TRA     DSLPED+1      RETURN IMMEDIATELY                        INV03960
  ERR5 CLA     =5            A(1,1) NOT IN EVEN CELL                   INV03970
       STO     ERRCD1                                                  INV03980
       TRA     DSLPED+1      RETURN IMMEDIATELY                        INV03990
  ERR6 CLA     =6                                                      INV04000
       TRA     ERR5+1                                                  INV04010
ERR3PL ADD     =10                                                     INV04020
       TRA     ERR3+3                                                  INV04030
ERR4PL ADD     =20                                                     INV04040
       TRA     ERR4+3                                                  INV04050
*                                                                      INV04060
*              STORAGE FOR PROGRAM CONSTANTS                           INV04070
*                                                                      INV04080
 TEMP8 PZE     0             STORAGE FOR CORE LOCATION 8 (DEC)         INV04090
FPTTRA TRA     FLPSPL                                                  INV04100
 CELL0 PZE     0             STORAGE FOR FLPSPL CODE                   INV04110
   DET PZE     0             ADDRESS OF DETERMINANT                    INV04120
 DETP1 PZE     0             ADDRESS OF LEAST SIG. PART OF DET.        INV04130
MULTPL PZE     0             ADDRESS OF REDUCTION FACTOR               INV04140
   TEN PZE     0             ADDRESS OF FLOATING POINT 10.             INV04150
 DETXP PZE     0             CELL FOR DETERMINANT EXPONENT             INV04160
```

```
     N PZE     0                                                        INV04170
  TWON PZE     0             2*N                                        INV04180
TWONSQ PZE     0             2*N**2                                     INV04190
   ADA PZE     0             ADDRESS OF MATRIX                          INV04200
ADPVEL PZE     0             ADDRESS OF CURRENT PIVOT ELEMENT           INV04210
ADPVRW PZE     0,7           ADDRESS OF CURRENT PIVOT ROW +2N           INV04220
ADOPEL PZE     0,6           ADDRESS OF ELEMENT BEING REDUCED           INV04230
ADOPRW PZE     0,7           ROW OF ADOPEL                              INV04240
AP2NSQ PZE     0,7           ADDRESS OF 1ST CELL BEYOND MATRIX          INV04250
ADRINT PZE     0,1           ADDRESS OF ROW INTEGERS + N                INV04260
ADCINT PZE     0,1           ADDRESS OF COLUMN INTEGERS + N             INV04270
LGSTRW PZE     0             ROW INDEX OF LARGEST ELEMENT IN SUB-MATRIX INV04280
LGSTCL PZE     0             COLUMN INDEX OF LARGEST ELEM. IN SUB-MATRIXINV04290
CHRCNG PZE     0             CHARACTERISTIC SCALE FACTOR                INV04300
ERRCD1 PZE     0             ERROR CODE 1                               INV04310
ERRCD2 PZE     0             ERROR CODE 2                               INV04320
 TEMP1 PZE     0                                                        INV04330
 TEMP2 PZE     0                                                        INV04340
TEMPXR PZE     0             TEMPORARY FOR ADDRESS ONLY                 INV04350
TEMPAC PZE     0             TEMPORARY STORAGE FOR FLPSPL               INV04360
TITLE  BCI     6,(1H1,10X,93HBELOW ARE THE PIVOT TERM                   INV04370
       BCI     7,S DERIVED DURING INVERSION AND THEIR ORIGI             INV04380
       BCI     6,NAL ROW - COLUMN LOCATIONS./1H0,22X,                   INV04390
       BCI     6,9HREDUCTION,8X,5HPIVOT,9X,3HROW,5X,                    INV04400
       BCI     6,6HCOLUMN/24X,5HSTAGE,11X,4HTERM,9X,                    INV04410
       BCI     6,6HNUMBER,3X,6HNUMBER/(1H0,24X,I3,6X,                   INV04420
       BCI     4,1PE14.6,6X,I3,6X,I3))                                  INV04430
 PRINT PZE     0                                                        INV04440
*              CLOSED SUBROUTINE TO INTERCHANGE ROWS                    INV04450
*              TWO ARGUMENTS -I,J=ROWS TO BE MOVED                      INV04460
*                                                                       INV04470
*                                                                       INV04480
INRCHR LDQ*    1,4                                                      INV04490
       MPY     TWON                                                     INV04500
       XCA                                                              INV04510
       ADD     ADA           ADDRESS OF ROW I + 2N                      INV04520
       STA     INR1                                                     INV04530
       STA     INR1+3                                                   INV04540
       LDQ*    2,4                                                      INV04550
       MPY     TWON                                                     INV04560
       XCA                                                              INV04570
       ADD     ADA           ADDRESS OF ROW I + 2 N                     INV04580
       STA     INR1+1                                                   INV04590
       STA     INR1+2                                                   INV04600
       LXA     TWON,7                                                   INV04610
  INR1 CLA     **,7          ROW I                                      INV04620
       LDQ     **,7          ROW J                                      INV04630
       STO     **,7          ROW J                                      INV04640
       STQ     **,7          ROW I                                      INV04650
       TIX     INR1,7,1                                                 INV04660
       TRA     3,4           DONE                                       INV04670
*                                                                       INV04680
*              CLOSED SUBROUTINE TO INTERCHANGE COLUMNS                 INV04690
*              TWO ARGUMENTS -I,J = COLUMNS TO BE MOVED                 INV04700
*                                                                       INV04710
INRCHC CLA     ADA                                                      INV04720
       SUB     =1                                                       INV04730
       ADD     TWONSQ                                                   INV04740
       STO     TEMP2         A-1+2*N**2                                 INV04750
       CLA*    1,4                                                      INV04760
       ALS     1                                                 INV04770
       ADD     TEMP2           ADDRESS OF COLUMN I+2N**2+1       INV04780
       STA     INC1                                              INV04790
       STA     INC1+3                                            INV04800
       CLA*    2,4                                               INV04810
       ALS     1                                                 INV04820
       ADD     TEMP2           ADDRESS OF COLUMN J + 2N**2+1     INV04830
       STA     INC1+1                                            INV04840
       STA     INC1+2                                            INV04850
       LXA     TWONSQ,7                                          INV04860
       LXA     TWON,6                                            INV04870
       SXD     INC2,6                                            INV04880
       LXA     =2,6                                              INV04890
  INC1 CLA     **,7            COLUMN I                          INV04900
       LDQ     **,7            COLUMN J                          INV04910
       STO     **,7            COLUMN J                          INV04920
       STQ     **,7            COLUMN I                          INV04930
       TXI     *+1,7,1         SMALL LOOP TO EXCHANGE LEAS. SIG. INV04940
       TIX     INC1,6,1                                          INV04950
       TXI     *+1,7,-2                                          INV04960
  INC2 TIX     INC1-1,7,0      MAIN LOOP -2N IN DECREMENT        INV04970
       TRA     3,4             DONE                              INV04980
*                                                                INV04990
*              CLOSED SUBROUTINE TO FIND THE LARGEST             INV05000
*              MAGNITUDE IN THE N-XR1+1 SQUARE SUB-MATRIX        INV05010
*              CURRENT REDUCTION STAGE IS IN XR1                 INV05020
*              ROW LOCATION OF L.E. = LGSTRW                     INV05030
*              COLUMN LOCATION OF L.E. = LGSTCL                  INV05040
*                                                                INV05050
FINDLE PXA     0,1                                               INV05060
       SUB     N                                                 INV05070
       SUB     =1                                                INV05080
       PAX     0,3             COUNT OF ROWS IN XR3=N+1-XR1      INV05090
       ALS     1                                                 INV05100
       STA     TEMPXR          TEMPXR=2(N+1-XR1)-TO GO INTO XR7  INV05110
       SXA     LGSTRW,1        START LOCATION AT PIVOT ELEMENT   INV05120
       SXA     LGSTCL,1                                          INV05130
       CLA     ADPVRW                                            INV05140
       STA     FLE1+1                                            INV05150
       STZ     TEMP1           KEEP LARGEST IN TEMP1             INV05160
       LXA     TEMPXR,7                                          INV05170
  FLE1 PXA     0,0                                               INV05180
       ADM     **,7                                              INV05190
       CAS     TEMP1                                             INV05200
       TRA     *+3             GREATER - EXCHANGE                INV05210
       TRA     *+5                                               INV05220
       TRA     *+4                                               INV05230
       STO     TEMP1                                             INV05240
       SXA     LGSTRW,3                                          INV05250
       SXA     LGSTCL,7                                          INV05260
       TIX     FLE1,7,2        LOOP BACK IF ROW NOT DONE         INV05270
       CAL     FLE1+1                                            INV05280
       ADD     TWON                                              INV05290
       STA     FLE1+1          INCREMENT TO NEW ROW              INV05300
       TIX     FLE1-1,3,1      LOOP BACK IF MORE ROWS            INV05310
       NZT     TEMP1           DONE, IS LARGEST ELEMENT = 0      INV05320
       TRA     ERR2            SINGULAR MATRIX ERROR RETURN      INV05330
*                              ADJUST LGSTRW, CL                 INV05340
       CLS     LGSTRW                                            INV05350
       ADD     N                                                 INV05360
       ADD     =1                                                       INV05370
       STA     LGSTRW                                                   INV05380
       CLS     LGSTCL                                                   INV05390
       ARS     1                                                        INV05400
       ADD     N                                                        INV05410
       ADD     =1                                                       INV05420
       STA     LGSTCL                                                   INV05430
       TRA     1,4                                                      INV05440
*                                                                       INV05450
*              CLOSED SUBROUTINE TO PERFORM ONE REDUCTION               INV05460
*              STAGE - ONE STAGE CONSISTS OF PRODUCING                  INV05470
*              ZEROS ON THE PIVOT COLUMN AND A 1 IN THE                 INV05480
*              PIVOT POSITION- ZEROS AND 1 ARE ONLY UNDERSTOOD          INV05490
*              DUE TO STORAGE OVER ITSELF                               INV05500
*              XR1=REDUCTION STAGE                                      INV05510
*                                                                       INV05520
REDUCE LXA     TWONSQ,6                                                 INV05530
       SXA     TEMPXR,1                                                 INV05540
       CLA     ADA                                                      INV05550
       ADD     TWON                                                     INV05560
       STA     ADOPRW        2N + ADDRESS OF ROW BEING REDUCED          INV05570
       SUB     TWON                                                     INV05580
       ADD     TEMPXR                                                   INV05590
       ADD     TEMPXR                                                   INV05600
       SUB     =2                                                       INV05610
       ADD     TWONSQ        2N**2 + ADDRESS OF ELEMENT BEING ZEROED    INV05620
       STA     ADOPEL                                                   INV05630
       AXT     1,5           COUNT OF ROWS BEING REDUCED                INV05640
REDUC1 PXA     0,5                                                      INV05650
       SUB     TEMPXR                                                   INV05660
       TZE     REDUC3        DO NOT OPERATE ON PIVOT ROW                INV05670
       DLD*    ADOPEL        ADOPEL HAS A TAG OF 6                      INV05680
       TZE     REDUC3        IF ALREADY ZERO, NO REDUCTION NECESSARY    INV05690
       DFDP*   ADPVEL                                                   INV05700
       CHS                   USE NEGATIVE RATIO                         INV05710
       DST*    MULTPL        REDUCTION FACTOR                           INV05720
       LXA     TWON,7                                                   INV05730
REDUC2 DLD*    ADPVRW        ADPVRW HAS A TAG OF 7                      INV05740
       DFMP*   MULTPL                                                   INV05750
       DFAD*   ADOPRW        ADOPRW HAS A TAG OF 7                      INV05760
       DST*    ADOPRW                                                   INV05770
       TIX     REDUC2,7,2                                               INV05780
       DLD*    MULTPL        PUT REDUCTION FACTOR WHERE                 INV05790
       DST*    ADOPEL        ZERO WAS PRODUCED                          INV05800
REDUC3 CLA     ADOPRW                                                   INV05810
       ADD     TWON                                                     INV05820
       STA     ADOPRW        GO TO NEXT ROW                             INV05830
       TXI     *+1,5,1       XR5 = ROW ABOUT TO BE REDUCED              INV05840
REDUC4 TIX     REDUC1,6T**   2N IN DECREMENT                            INV05850
       TRA     1,4           DONE                                       INV05860
*                                                                       INV05870
*              CLOSED SUBROUTINE TO SCALE AN INCOMING                   INV05880
*              NUMBER SO THAT IT IS LESS THAN 10. AND                   INV05890
*              GREATER THAN OR EQUAL TO 1. DIVISIONS AND                INV05900
*              MULTIPLICATIONS KEPT TRACK OF IN DETXP.                  INV05910
*              NUMBER EXPECTED IN AC AND MQ-RESULT LEFT THERE           INV05920
*                                                                       INV05930
SCALE  STO     TEMPAC                                                   INV05940
       SSP                                                              INV05950
       LRS     0                                                        INV05960
```

```
SCALE1 CAS*    TEN                                                      INV05970
       TRA     DIVIDE                                                   INV05980
       TRA     DIVIDE                                                   INV05990
TSTONE CAS     =1.                                                      INV06000
       TRA     CHKSGN                                                   INV06010
       TRA     CHKSGN                                                   INV06020
       DFMP*   TEN                                                      INV06030
       DST*    MULTPL        TEMPORARY STORAGE                          INV06040
       CLA     DETXP                                                    INV06050
       SUB     =1                                                       INV06060
       STO     DETXP                                                    INV06070
       DLD*    MULTPL                                                   INV06080
       TRA     TSTONE                                                   INV06090
DIVIDE DFDP*   TEN                                                      INV06100
       DST*    MULTPL                                                   INV06110
       CLA     DETXP                                                    INV06120
       ADD     =1                                                       INV06130
       STO     DETXP                                                    INV06140
       DLD*    MULTPL                                                   INV06150
       TRA     SCALE1                                                   INV06160
CHKSGN DST*    MULTPL                                                   INV06170
       CLA     TEMPAC                                                   INV06180
       LRS     0                                                        INV06190
       CLA*    MULTPL                                                   INV06200
       LLS     0                                                        INV06210
       TRA     1,4                                                      INV06220
*                                                                       INV06230
*              FLOATING POINT SPILL ROUTINE TO ANALYZE                  INV06240
*              OVER/UNDER FLOW DURING DOUBLE PRECISION                  INV06250
*              OPERATIONS                                               INV06260
*                                                                       INV06270
FLPSPL STO     TEMPAC                                                   INV06280
       CLA     0                                                        INV06290
       STD     CELLO                                                    INV06300
       CLA     CELLO                                                    INV06310
       CAS     =3B17                                                    INV06320
       TRA     TSTSTO        CHECK TO BE SURE IT IS NOT A STORAGE TRAP  INV06330
       TRA     *+4           UNDERFLOW IN AC AND MQ                     INV06340
       CLA     TEMPAC        UNDERFLOW IN MQ ONLY                       INV06350
       LDQ     =0                                                       INV06360
       TRA*    0             RETURN                                     INV06370
       PXA     0,0                                                      INV06380
       TRA     *-3                                                      INV06390
TSTSTO CAS     =7B17                                                    INV06400
       TRA     ERR6          ODD STORAGE TRAP                           INV06410
       TRA     ERR1          OVERFLOW IN AC OR AC AND MQ                INV06420
       TRA     ERR1                                                     INV06430
*                                                                       INV06440
       END                                                              INV99990
```

SUBROUTINE DATASB

```
$IBMAP DATASB   4,DECK,M94/2                                                    DAT00000
       ENTRY    DATA                                                            DAT00010
 DATA  PZE      12000                                                           DAT00020
       PZE      8000                                                            DAT00030
       BSS      11999                                                           DAT00040
       END                                                                      DAT99990
```

SUBROUTINE KRD

```
$IBMAP FKRD     100,DECK,XR7,M94
*KRD   7090 FORTRAN LIBRARY / BCD TAPE INPUT ROUTINE                    KRD00010
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * KRD00020
*                                                                       KRD00030
*     M = KRD (A,NZ,IRROR,NFC,NCOL,NWT,LOGIC)                           KRD00040
*                                                                       KRD00050
*            A - BEGINNING STORAGE LOCATION.                            KRD00060
*           NZ - IF ZERO, WILL EXIT AFTER EACH CARD.                    KRD00070
*                IF ONE, WILL EXIT AFTER END-FILE-CODE(12 PCH-COL 72)   KRD00080
*        IRROR - LOCATION WHERE ERROR CODES ARE STORED.                 KRD00090
*                0  SUCCESSFUL.                                         KRD00100
*                1  PHYISCAL END-OF-FILE ON TAPE.                       KRD00110
*                2  NFC*NCOL GREATER THAN 72.                           KRD00120
*                3  IMPROPER NUMBER FOLLOWING B.                        KRD00130
*                4  ILLEGAL CHARACTER IN DATA FIELD.                    KRD00140
*                5  DIVIDE CHECK IN CONVERTING TO FX PT.                KRD00150
*                6  OVERFLOW CONVERTING TO FLOATING BINARY.             KRD00160
*                7  EFFECTIVE POWER GREATER THAN 38.                    KRD00170
*                8  FIELD VALUE GREATER THAN 34,359,738,367.            KRD00180
*                9  ILLEGAL CHARACTER IN COLUMN 72.                     KRD00190
*               10  MACHINE FAILURE.                                    KRD00200
*               11  END OF BUFFER ERROR READING                         KRD00210
*          NFC - NUMBER OF FIELDS TO CONVERT.                           KRD00220
*         NCOL - NUMBER OF COLUMNS PER FIELD.                           KRD00230
*          NWT - NUMBER OF WORDS FOLLOWING THE CONVERSION FIELDS TO     KRD00240
*                  TRANSFER AS UNCONVERTED BCD WORDS.                   KRD00250
*        LOGIC - LOGICAL TAPE NUMBER                                    KRD00260
*            M - NUMBER OF CARDS SUCCESSFULLY CONVERTED.                KRD00270
*                                                                       KRD00271
* CONVERSION OF BCD CARD IMAGES IN CORE                                 KRD00272
*     CALL KRDG (A,B,IRROR,NFC,NCOL)                                    KRD00273
*                                                                       KRD00274
*               B - LOCATION OF 1ST WORD OF BCD FIELDS                  KRD00275
*                      TO BE CONVERTED.                                 KRD00276
*                      2ND WORD AT B+1, ETC.                            KRD00277
*                                                                       KRD00280
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * KRD00290
       REM                                                              KRD00300
       ENTRY   KRD                                                      KRD00310
       ENTRY   KRDG                                                     KRD00315
       LDIR                                                             KRD00320
 KRD   STZ     CLAUDE                                                   KRD00330
       TRA     CART                                                     KRD00331
 KRDG  STL     CLAUDE                                                   KRD00332
 CART  SAVE    4,1,2,I                                                  KRD00333
 PRE   TXI     *+1,4,-2                                                 KRD00340
       SXA     IR4,4                                                    KRD00350
       SXA     IR2,2                                                    KRD00360
       SXA     IR1,1                                                    KRD00370
       STZ     CDCT                                                     KRD00380
       NZT     CLAUDE                                                   KRD00381
       TRA     *+3                                                      KRD00382
       CLA     2,4                                                      KRD00383
       TRA     LOCATE+5                                                 KRD00384
       CLA*    7,4                                                      KRD00390
       STO     ALPHA+4                                                  KRD00400
       CALL    .FVIO.(ALPHA+4,ALPHA+5)                                  KRD00410
```

```
        CLA     ALPHA+5                                                KRD00420
        STA     ROPEN+1                                                KRD00430
        STA     LOCATE+1                                               KRD00440
        STA     LOCTWO+1                                               KRD00450
        PAC     0,4                                                    KRD00460
        LDI     1,4                                                    KRD00470
        LFT     040000                                                 KRD00480
        TRA     LOCATE                                                 KRD00490
 ROPEN  TSX     .OPEN,4                                                KRD00500
        MZE     **                                                     KRD00510
LOCATE  TSX     .READ,4                                                KRD00520
        PZE     **,,ER11                                               KRD00530
        PZE     ER1,,ER10                                              KRD00540
        IORTN   **,,**                                                 KRD00550
        CLA     *-1                                                    KRD00560
        STA     LDQ                                                    KRD00570
        STA     ALOOP                                                  KRD00580
        ADD     =11                                                    KRD00590
        STA     SETAD                                                  KRD00600
        STA     LAST-2                                                 KRD00610
        LXA     IR4,4                                                  KRD00620
        CLA*    2,4                                                    KRD00630
        STO     TEST                                                   KRD00640
        CLA     BFILL                                                  KRD00650
        STD     BDEC                                                   KRD00660
        CLA     SWONE                                                  KRD00670
 KRDA   STA     SW                                                     KRD00680
        AXT     10,1                                                   KRD00690
 SWALT  PXA     0,1                                                    KRD00700
        STA*    3,4                                                    KRD00710
        CLA     1,4                                                    KRD00720
        STA     STORE                                                  KRD00730
        CLA*    4,4                                                    KRD00740
        STA     NFC                                                    KRD00750
        XCA                                                            KRD00760
        CLA*    5,4                                                    KRD00770
        STO     NCOL                                                   KRD00780
        MPY     NCOL                                                   KRD00790
        XCA                                                            KRD00800
        LXA     ZERO,4                                                 KRD00810
        CAS     =72                                                    KRD00820
        TRA     ER2                                                    KRD00830
        TXI     *+1,4,-1                                               KRD00840
        SXA     LAST,4                                                 KRD00850
 AGAIN  LXA     =077777,4                                              KRD00860
        TOV     *+1                                                    KRD00870
        LXA     NCOL,2                                                 KRD00880
        SXD     NFCC,4                                                 KRD00890
        CAL     =017                                                   KRD00900
        STD     WDCT                                                   KRD00910
        STZ     PWR                                                    KRD00920
        ANA     **                                                     KRD00930
        LAC     NFC,4                                                  KRD00940
 LAST   AXT     **,1                                                   KRD00950
        TZE     *+3                                                    KRD00960
        AXT     0,1                                                    KRD00970
        PAC     **,4                                                   KRD00980
        TXL     IR4,4,0                                                KRD00990
        SXD     ALL-1,1                                                KRD01000
        SXD     NFT,4                                                  KRD01010
```

```
       TXL    *+2,4,-2                                      KRD01020
       STD    NFCC                                          KRD01030
BACK   CLA    *                                             KRD01040
       STD    STAR1                                         KRD01050
CLS    CLS    =0                                            KRD01060
       STO    ALPHA+1                                       KRD01070
       STO    ALPHA+2                                       KRD01080
LOOP   LXD    WDCT,4                                        KRD01090
LDQ    LDQ    **,4                                          KRD01100
       AXT    6,1                                           KRD01110
BDEC   TXI    *+1,4,-1                                      KRD01120
       SXD    WDCT,4                                        KRD01130
ZERO   PXD    0,0                                           KRD01140
       LGL    6                                             KRD01150
SWONE  PAX    SW+1,4                                        KRD01160
       TXL    NUM,4,9                                       KRD01170
       TXL    ER4,4,15                                      KRD01180
       TXL    NEXT,4,16                                     KRD01190
       TXL    ER4,4,17                                      KRD01200
       TXL    FIXED,4,18                                    KRD01210
       TXL    ER4,4,20                                      KRD01220
       TXL    FLOAT,4,21                                    KRD01230
       TXL    ER4,4,26                                      KRD01240
       TXL    POINT,4,27                                    KRD01250
       TXL    ER4,4,31                                      KRD01260
       TXL    MINUS,4,42                                    KRD01270
       TXL    ER4,4,47                                      KRD01280
       TXL    NEXT,4,48                                     KRD01290
ER4    AXT    4,4             ILLEGAL CHARACTER             KRD01300
       TRA    SCRAM                                         KRD01310
ER1    AXT    1,4             END OF FILE                   KRD01320
       TRA    SCRAM                                         KRD01330
ER2    AXT    2,4             CF 772                        KRD01340
       TRA    SCRAM                                         KRD01350
ER5    AXT    5,4             SCALING TOO LARGE             KRD01360
       TRA    SCRAM                                         KRD01370
ER6    AXT    6,4             FL. PT. OVERFLOW              KRD01380
       TRA    SCRAM                                         KRD01390
ER7    AXT    7,4             FL. EXP. OUT OF RANGE         KRD01400
       TRA    SCRAM                                         KRD01410
ER9    AXT    9,4             ILLEGAL CHAR. COL. 72         KRD01420
       TRA    SCRAM                                         KRD01430
ER10   AXT    10,4                                          KRD01440
       TRA    SCRAM                                         KRD01450
ER11   AXT    11,4                                          KRD01460
SCRAM  PXA    0,4                                           KRD01470
       LXA    IR4,4                                         KRD01480
       STO*   3,4                                           KRD01490
       PXD    0,0                                           KRD01500
       TRA    IR2                                           KRD01510
POINT  STZ    ALPHA+2                                       KRD01520
       TRA    NEXT                                          KRD01530
MINUS  TXL    NOTL,4,34                                     KRD01540
       TXH    NOTL,4,35                                     KRD01550
       TXH    NOTL,2,1                                      KRD01560
       LXA    IR4,4                                         KRD01570
       CLA    1,4                                           KRD01580
       ADD    =1B17                                         KRD01590
       ADD    ALPHA+1                                       KRD01600
       STA    STORE                                         KRD01610
       TRA     NF                                                     KRD01620
NOTL   SUB     =040                                                   KRD01630
       TXL     *+2,4,42                                               KRD01640
       SUB     =10                                                    KRD01650
       LXD     CLS,4                                                  KRD01660
       SXD     STAR1,4                                                KRD01670
NUM    STO     ALPHA                                                  KRD01680
       CLA     ALPHA+1                                                KRD01690
       ALS     3                                                      KRD01700
       ADD     ALPHA+1                                                KRD01710
       ADD     ALPHA+1                                                KRD01720
       ADD     ALPHA                                                  KRD01730
       SSP                                                            KRD01740
       TNO     *+3                                                    KRD01750
       AXT     8,4                CONVERSION OVERFLOW                 KRD01760
       TRA     SCRAM                                                  KRD01770
       STO     ALPHA+1                                                KRD01780
       CLA     ALPHA+2                                                KRD01790
       TMI     NEXT                                                   KRD01800
       CLA     PWR                                                    KRD01810
       SUB     =1                                                     KRD01820
       STO     PWR                                                    KRD01830
NEXT   TNX     ENDFD,2,1                                              KRD01840
       TIX     ZERO,1,1                                               KRD01850
       TRA     LOOP                                                   KRD01860
FIXED  BSS     0                                                      KRD01870
FLOAT  SSM                                                            KRD01880
       STO     ALPHA+2                                                KRD01890
       XEC     STAR1                                                  KRD01900
       STO     ALPHA+3                                                KRD01910
       CLA     PT2                                                    KRD01920
       STA     NEXT                                                   KRD01930
       CLA     *                                                      KRD01940
       STD     STAR1                                                  KRD01950
       CLS     =0                                                     KRD01960
       STO     ALPHA+1                                                KRD01970
       TRA     NEXT                                                   KRD01980
PT2    PZE     ENDEX                                                  KRD01990
PT1    PZE     ENDFD                                                  KRD02000
ENDEX  CLA     PT1                                                    KRD02010
       STA     NEXT                                                   KRD02020
       LXA     ALPHA+2,4                                              KRD02030
       XEC     STAR1                                                  KRD02040
       TIX     ERTN,4,19                                              KRD02050
BRTN   TNZ     *+3                                                    KRD02060
       TPL     *+2                                                    KRD02070
       CLA     =35                                                    KRD02080
       SUB     =35                                                    KRD02090
       TMI     *+4                                                    KRD02100
       TZE     *+3                                                    KRD02110
ER3    AXT     3,4                NEGATIVE SCALING                    KRD02120
       TRA     SCRAM                                                  KRD02130
       STA     SHIFT                                                  KRD02140
       STQ     ALPHA+2                                                KRD02150
       LDQ     ALPHA+3                                                KRD02160
       PXD     0,0                                                    KRD02170
SHIFT  LLS     **                                                     KRD02180
       LXA     PWR,4                                                  KRD02190
       DCT                                                            KRD02200
       TRA     *+1                                                    KRD02210
```

```
        DVP     10T,4                                                   KRD02220
        DCT                                                             KRD02230
        TRA     ER5                                                     KRD02240
        TOV     ER3                                                     KRD02250
        ALS     1                                                       KRD02260
        STQ     ALPHA                                                   KRD02270
        LDQ     *                                                       KRD02280
        LAS     10T,4                                                   KRD02290
        NOP                                                             KRD02300
        LDQ     MINUS                                                   KRD02310
        CLA     ALPHA                                                   KRD02320
        RND                                                             KRD02330
        TRA     STORE                                                   KRD02340
ERTN    ADD     PWR                                                     KRD02350
        STO     PWR                                                     KRD02360
        CLA     ALPHA+3                                                 KRD02370
        TRA     *+2                                                     KRD02380
ENDFD   BSS     0                                                       KRD02390
STAR1   CLA     ALPHA+1                                                 KRD02400
        STQ     ALPHA+2                                                 KRD02410
        TZE     STORE                                                   KRD02420
        LFTM                                                            KRD02430
        LRS     8                                                       KRD02440
        TNZ     *+3                                                     KRD02450
        ORA     =0232000000000                                          KRD02460
        TRA     *+2                                                     KRD02470
        ORA     =0243000000000                                          KRD02480
        STO     ALPHA                                                   KRD02490
        CLA     =0466000000                                             KRD02500
        LLS     8                                                       KRD02510
        FAD     ALPHA                                                   KRD02520
        FRN                                                             KRD02530
        LXA     PWR,4                                                   KRD02540
        TXL     SAVE,4,0                                                KRD02550
        XCA                                                             KRD02560
        CLA     PWR                                                     KRD02570
        TXH     ER7,4,38                                                KRD02580
        TMI     DIV                                                     KRD02590
        FMP     PWR10,4                                                 KRD02600
        TRA     OUT                                                     KRD02610
DIV     XCA                                                             KRD02620
        FDP     PWR10,4                                                 KRD02630
        STQ     ALPHA                                                   KRD02640
        FDH     PWR10,4                                                 KRD02650
        PXA     0,0                                                     KRD02660
        TQO     *+2                                                     KRD02670
        XCA                                                             KRD02680
        FAD     ALPHA                                                   KRD02690
OUT     FRN                                                             KRD02700
        TOV     ER6                                                     KRD02710
SAVE    EFTM                                                            KRD02720
STORE   STO     **                                                      KRD02730
        CLA     STORE                                                   KRD02740
        ADD     INCR                                                    KRD02750
        STA     STORE                                                   KRD02760
        LDQ     ALPHA+2                                                 KRD02770
NF      LXD     NFCC,4                                                  KRD02780
        TNX     ALL,4,1                                                 KRD02790
        SXD     NFCC,4                                                  KRD02800
        CLA     *                                                       KRD02810
```

```
       STD     STAR1                                                    KRD02820
       CLS     =0                                                       KRD02830
       STO     ALPHA+1                                                  KRD02840
       STO     ALPHA+2                                                  KRD02850
       STZ     PWR                                                      KRD02860
       LXA     NCOL,2                                                   KRD02870
 NFT   TXH     NEXT+1,4,**                                              KRD02880
       STD     NFCC                                                     KRD02890
       TXI     NEXT+1,2,-1                                              KRD02900
 ALL   BSS     0                                                        KRD02910
 IR4   AXT     **,4                                                     KRD02920
 SW    TRA     **                                                       KRD02930
       CLA     CDCT                                                     KRD02940
       ADD     =1                                                       KRD02950
       STO     CDCT                                                     KRD02960
       ZET     CLAUDE                                                   KRD02961
       TRA     EXIT                                                     KRD02962
       CLA*    6,4                                                      KRD02970
       PAX     0,1                                                      KRD02980
       TXL     BLOOP,1,0                                                KRD02990
       LXD     WDCT,2                                                   KRD03000
 ALOOP CLA     0,2                                                      KRD03010
       XEC     STORE                                                    KRD03020
       CLA     STORE                                                    KRD03030
       ADD     INCR                                                     KRD03040
       STA     STORE                                                    KRD03050
 BFILL TXI     *+1,2,-1                                                 KRD03060
       TIX     ALOOP,1,1                                                KRD03070
 BLOOP CLA     TEST                                                     KRD03080
       TZE     EXIT                                                     KRD03090
 SETAD CLA     0                                                        KRD03100
       ALS     9                                                        KRD03110
       PAX     0,2                                                      KRD03120
       TXH     MTEST,2,8191                                             KRD03130
LOCTWO TSX     .READ,4                                                  KRD03140
       PZE     **,,ER11                                                 KRD03150
       PZE     ER1,,ER10                                                KRD03160
       IORTN   **,,**                                                   KRD03170
       CLA     *-1                                                      KRD03180
       STA     LDQ                                                      KRD03190
       STA     ALOOP                                                    KRD03200
       ADD     =11                                                      KRD03210
       STA     SETAD                                                    KRD03220
       STA     LAST-2                                                   KRD03230
       TRA     AGAIN                                                    KRD03240
 MTEST TXH     ER9,2,24576                                              KRD03250
       TXH     LOCTWO,2,24575                                           KRD03260
       TXH     ER9,2,13312                                              KRD03270
 EXIT  PXD     0,0                                                      KRD03280
       STO*    3,4                                                      KRD03290
 IR2   AXT     **,2                                                     KRD03300
 IR1   AXT     **,1                                                     KRD03310
       CLA     CDCT                                                     KRD03320
       TRA     CART+1                                                   KRD03330
*                                                                       KRD03340
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * KRD03350
*                                                                       KRD03360
 INCR  PZE     1                                                        KRD03370
ALPHA  BSS     6                                                        KRD03380
CLAUDE DEC     0                                                        KRD03381
```

```
 TEST   BSS      1                                                             KRD03390
 NFC    BSS      0                                                             KRD03400
 NFCC   BSS      1                                                             KRD03410
 NCOL   BSS      0                                                             KRD03420
 WDCT   BSS      1                                                             KRD03430
 CDCT   BSS      1                                                             KRD03440
 PWR    BSS      1                                                             KRD03450
        DEC      1000000000 ,10000*000*,100000000,10000000                     KRD03460
        DEC      1000000,100000,10000,1000,100,10                              KRD03470
 10T    PZE      1                                                             KRD03480
ZPWR10  OCT 377454732313,373741367021,370601137164                             KRD03490
        OCT 365464114135,361755023373,356612334311                             KRD03500
        OCT 353473426555,347770675742,344623713116                             KRD03510
        OCT 341503074077,336402374714,332635456171                             KRD03520
        OCT 327512676456,324410545213,320647410336                             KRD03530
        OCT 315522640262,312417031702,306661534466                             KRD03540
        OCT 303532743536,300425434430,274674055532                             KRD03550
        OCT 271543212741,266434157116,262706576512                             KRD03560
        OCT 257553630410,254443023471,250721522450                             KRD03570
        OCT 245564416672,242452013710,236734654500                             KRD03580
        OCT 233575360400,230461132000,224750220000                             KRD03590
        OCT 221606500000,216470400000,212764000000                             KRD03600
        OCT 207620000000,204500000000,201400000000                             KRD03610
 END    BSS      0                                                             KRD03620
 PWR10  SYN      END-1                                                         KRD03630
*                                                                              KRD03640
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *        KRD03650
        REM                                                                    KRD03660
        END                                                                    KRD03670
```

SUBROUTINE BSF

```
$IBMAP FBSF    100,LIST,DECK,M94                                        BSF00010
*     BACK-SPACE FILE SUBROUTINE / BSF                                  BSF00020
*                                                                       BSF00050
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * BSF00060
*                                                                       BSF00070
*     CALL BSF (NFILE,LTAPE,LERROR)                                     BSF00080
*                                                                       BSF00090
*          NFILE  = NUMBER OF FILES TO BE SPACED.  THE TAPE IS ALWAYS   BSF00100
*                   LEFT POSITIONED AT THE BEGINNING OF SOME FILE.      BSF00110
*                   0  MEANS BACKSPACE TO BEGINNING OF CURRENT FILE.    BSF00120
*                   1  MEANS BACKSPACE TO BEGINNING OF PRECEDING FILE,  BSF00130
*                      ETC.                                             BSF00140
*          LTAPE  = LOGICAL TAPE UNIT TO BE USED.                       BSF00150
*          LERROR = LOCATION IN WHICH ERROR CODE IS TO BE STORED.       BSF00160
*                   0  INDICATES SUCCESS.                               BSF00170
*                   N  INDICATES NUMBER OF FILES NOT SPACED WHEN        BSF00180
*                      BEGINNING OF TAPE WAS REACHED.                   BSF00190
*                                                                       BSF00200
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * BSF00210
       REM                                                              BSF00220
       LDIR                                                             BSF00230
       REM                                                              BSF00240
       REM                                                              BSF00250
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * BSF00260
BSF    SAVE    4,2,1,I                                                  BSF00270
       CLA*    4,4                                                      BSF00280
       STO     TEMP                                                     BSF00290
       CALL    .FVIO.(TEMP,TEMP+1)                                      BSF00300
       CLA     TEMP+1                                                   BSF00310
       STA     SETA                                                     BSF00320
       STA     SETB                                                     BSF00330
       LXA     ..0001,4                                                 BSF00340
       CLA*    3,4                                                      BSF00350
       PAX     0,1                                                      BSF00360
       TXI     *+1,1,1                                                  BSF00370
       LAC     TEMP+1,2                                                 BSF00380
       LDI     1,2                                                      BSF00390
       LNT     040000                                                   BSF00400
       TRA     SETA+1                                                   BSF00410
       TSX     .CLOSE,4                                                 BSF00420
SETA   MON     **                                                       BSF00430
CONT   TSX     .NDSEL,4                                                 BSF00440
       PZE     0,2,6                                                    BSF00450
       AXC     2,4                                                      BSF00460
       NZT*    0,2                                                      BSF00470
       TRA     SETN                                                     BSF00480
       TIX     CONT,1,1                                                 BSF00490
       AXT     WAIT,4                                                   BSF00500
       SXA     WAIT,4                                                   BSF00510
       CLA     0,2                                                      BSF00520
       PAC     0,1                                                      BSF00530
       ZET     1,1                                                      BSF00540
       TRA     *-1                                                      BSF00550
       LDQ     SETWD                                                    BSF00560
       STQ     1,1                                                      BSF00570
       TSX     .ACTV,4                                                  BSF00580
       MZE     0,2                                                      BSF00590
```

```
WAIT   TRA     *                                                        BSF00600
SETWD  TWO     COM,,SELRT                                               BSF00610
COM    IORT    TEMP+4,,10                                               BSF00620
MPC    LXA     ..0001,4                                                 BSF00630
       STZ*    5,4                                                      BSF00640
MPCA   TSX     .OPEN,4                                                  BSF00650
SETB   MON     **                                                       BSF00660
       RETURN  BSF                                                      BSF00670
SETN   TXI     *+1,1,-1                                                 BSF00680
       PXA     0,1                                                      BSF00690
       LXA     ..0001,4                                                 BSF00700
       STO*    5,4                                                      BSF00710
       TRA     MPCA                                                     BSF00720
SELRT  TPL     SELPL                                                    BSF00730
       AXT     MPC,2                                                    BSF00740
       SXA     WAIT,2                                                   BSF00750
       PAC     0,2                                                      BSF00760
       STZ     1,2                                                      BSF00770
       TRA     1,4                                                      BSF00780
SELPL  PAC     0,2                                                      BSF00790
       CLA     1,2                                                      BSF00800
       STA*    .RCHX                                                    BSF00810
       TRA     1,4                                                      BSF00870
       REM                                                              BSF00880
       LORG                                                             BSF00890
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * BSF00900
*                                                                       BSF00910
ERASE  CONTRL  ER                                                       BSF00920
       USE     ER                                                       BSF00930
TEMP   BSS     20                                                       BSF00940
       END                                                              BSF00950
```

SUBROUTINE FSF

```
$IBMAP FFSF    50,DECK,M94
*FSF     709/90 FORTRAN LIBRARY / FORWARD SPACE FILE
*
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*
*     CALL FSF (NFILE,LTAPE,LERROR)
*
*          NFILE  - NUMBER OF END-OF-FILE MARKS TO SPACE PASS.
*                   ZERO IS EQUIVALENT TO ONE.
*          LTAPE  - LOGICAL TAPE NUMBER.
*          LERROR - LOCATION IN WHICH THE ERROR CODE IS STORED.
*                   0  INDICATES SUCCESS.
*                   N  INDICATES NUMBER OF UNSPACED FILES WHEN
*                      END-OF-TAPE SIGNAL WAS REACHED (SEE MM-23).
*
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
       REM
       LDIR
       REM
       REM
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
FSF    SAVE    (4,2,1)I
       CLA*    4,4
       STO     TEMP                  LOGICAL UNIT
       CLA*    3,4
       PAX     0,1                   CTR TO XR1
       CALL    .FVIO.(TEMP,TEMP+1)
       LAC     TEMP+1,2
       LDI     1,2
       CLA     TEMP+1
       STA     SETA
       STA     SETX
       LFT     040000
       TRA     LOOP
       TSX     .OPEN,4
SETX   MON     **
LOOP   TSX     .READ,4               READ TO EOF
SETA   PZE     **,,0
       PZE     EOF,,ERR
       IOCP    SKIM,0,2
       IORTN   **,0,-1
ERR    CAL     SKIM+1
       LAS     CODE                  IF TAPEND
       TRA     LOOP
       TRA     ERRA
       TRA     LOOP
EOF    TIX     LOOP,1,1
       LXA     ..0001,4
       STZ*    5,4                   SET N=0
       RETURN  FSF
ERRA   PXA     0,1                   SET N TO CTR OF
       LXA     ..0001,4                UNSKIPPED FILES
       STO*    5,4
       TRA     ERRA-1
CODE   BCI     1,TAPEND
       LORG
ERASE  CONTRL  ER
```

SUBROUTINE FSR

```
$IBMAP FFSR    50,LIST,DECK,M94                                         FSR00010
*     FORWARD SPACE RECORD / FSR                                        FSR00020
*                                                                       FSR00060
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * FSR00070
*                                                                       FSR00080
*     CALL FSR (NREC,LTAPE,LERROR)                                      FSR00090
*                                                                       FSR00100
*          NREC - NUMBER OF FORTRAN LOGICAL RECORDS TO SPACE FORWARD.   FSR00110
*         LTAPE - LOGICAL TAPE NUMBER.                                  FSR00120
*        LERROR - LOCATION IN WHICH THE ERROR CODE IS STORED.           FSR00130
*                 0  INDICATES SUCCESS.                                 FSR00140
*                 N  INDICATES NUMBER OF UNSPACED RECORDS WHEN AN       FSR00150
*                    END-OF-FILE MARK WAS FOUND.  TAPE LEFT SPACED IN   FSR00160
*                    FRONT OF EOF.                                      FSR00170
*                                                                       FSR00180
*     CALL      FSPR(NPREC,LTAPE,LERROR)                                FSR00190
*                                                                       FSR00200
*         NPREC - NUMBER PHYSICAL RECORDS TO SPACE FORWARD.             FSR00210
*                                                                       FSR00220
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * FSR00230
       REM                                                              FSR00240
       ENTRY   FSR                                                      FSR00250
       ENTRY   FSPR                                                  M3 FSR00260
       REM                                                              FSR00270
       REM                                                              FSR00280
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * FSR00290
       LDIR                                                             FSR00300
FSPR   STZ     CODE                                                     FSR00310
       TRA     *+2                                                      FSR00320
FSR    STL     CODE                                                     FSR00330
TURN   SAVEN   4,2,1,I                                                  FSR00340
       CLA*    4,4                                                      FSR00350
       STO     TEMP                                                     FSR00360
       CLA*    3,4                                                      FSR00370
       PAX     0,1                                                      FSR00380
       TZE     WIND                                                     FSR00390
       CALL    .FVIO.(TEMP,TEMP+1)                                      FSR00400
       LAC     TEMP+1,2                                                 FSR00410
       SCA     SETA,2                                                   FSR00420
       SCA     SETB,2                                                   FSR00430
       LDI     1,2                                                      FSR00440
       LFT     040000                                                   FSR00450
       TRA     READL                                                    FSR00460
       TSX     .OPEN,4                                                  FSR00470
SETB   MON     **                                                       FSR00480
READL  TSX     .READ,4                                                  FSR00490
SETA   PZE     **,,0                                                    FSR00500
       PZE     EOF,,ERR                                                 FSR00510
       IOCP    SKIM,0,2                                                 FSR00520
       IORTN   **,0,-1                                                  FSR00530
ERR    LXA     SKIM,4                                                   FSR00540
       ZET     CODE                                                     FSR00550
       TXL     READL,4,0                                                FSR00560
       TIX     READL,1,1                                                FSR00570
       PXD     0,0                                                      FSR00580
DONE   LXA     ..0001,4                                                 FSR00590
       STO*    5,4                                                      FSR00600
       RETURN  TURN                                                     FSR00610
EOF    TSX     .NDSEL,4                                                 FSR00620
       PZE     0,2,5                                                    FSR00630
       NOP                                                              FSR00640
WIND   PXA     0,1                                                      FSR00650
       TRA     DONE                                                     FSR00660
*                                                                       FSR00670
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * FSR00680
*                                                                       FSR00690
ERASE  CONTRL  ER                                                       FSR00700
       USE     ER                                                       FSR00710
TEMP   BSS     2                                                        FSR00720
SKIM   BSS     2                                                        FSR00730
CODE   BSS     1                                                        FSR00740
       BSS     15                                                       FSR00750
*                                                                       FSR00760
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * FSR00770
       REM                                                              FSR00780
       END                                                              FSR00790
```

APPENDIX II

SUBROUTINES READTP, WRTETP, FVIO, FILE, INRPRD, AND FRUN

1. SUBROUTINE READTP DESCRIPTION

Subroutine READTP reads a binary tape in the format of the 7094 matrix interpretive scheme (TL01).

Subroutine READTP has the following restrictions:

- The matrix on tape must be written by subroutine WRTETP, a TL01 program, or its equivalent.
- Tape spacing subroutines FSF, FSR, and BSF are used by READTP.
- Tape reading is done by FORTRAN IV I/O subroutines.
- Only one- or two-dimensional arrays can be written on tape.

a. Calling Sequence

The calling sequence and descriptions of the READTP arguments are as follows:

Parameter	Function
A	(1, 1) element of the matrix to be read from tape. If this is not A(1, 1), the designated submatrix is read. (This is a method of departitioning matrices as they are read from tape.)
K	Row DIMENSION statement entry for A. This must be 1 if A is a singular dimensioned variable.
NAME	Name of matrix as it is read from tape. If NAME is nonzero upon entry to READTP, the name coming from the tape is compared to the incoming NAME and, if there is no agreement, an error return occurs. If the two names are the same, the name from the tape is stored in NAME.
M	Number of rows in the matrix
N	Number of columns in the matrix
B	Words 5 through 16 of the 16_{10}-word matrix identification

Parameter	Function
NFILE	Number of file marks to be passed before reading starts. If 0, no file spacing takes place. If negative, backspacing occurs and NFILE end-of-file marks are passed. Then, the tape is spaced forward and past the last file mark encountered. The tape is always at the beginning of a file after any file spacing.
NMAT	Number of matrices to be passed before reading starts. If 0, no matrix spacing takes place. A negative value is illegal, because backward spacing of matrices is not allowed. All matrix spacing takes place after file spacing is complete.
NTAPE	Logical tape number
IRROR	0 if successfully read; 1 if file spacing error; 2 if matrix spacing is negative; 3 if matrix spacing error; 4 if checksum error; 5 if name on tape is wrong

b. Space Required

Subroutine READTP requires 330 cells. Also, 134 cells of storage are required for subroutines FSR, FSF, and BSF.

c. Tape Format

The matrix must be written in two FORTRAN logical records. This is automatically satisfied if the tape is written by WRTETP or TL01.

2. SUBROUTINE WRTETP DESCRIPTION

Subroutine WRTETP writes a matrix on binary tape in a format consistent with the 7094 matrix interpretive scheme (TL01).

This subroutine has the following restrictions:

- The matrix must be in the core in normal FORTRAN IV order.
- Tape spacing subroutines FSF, FSR, and BSF are used by subroutine WRTETP.
- Tape writing is done by FORTRAN IV I/O subroutines.
- Only one- or two-dimensional arrays can be written on tape.

a. Calling Sequence

The calling sequence and descriptions of the READTP arguments are as follows:

Parameter	Function
A	(1, 1) element of the matrix to be written on tape. If this is not A(1, 1), then the designated submatrix is put on tape.
K	Row DIMENSION statement entry for A. This is 1 if A is a singular dimensioned variable.
NAME	Name of the matrix; a fixed-point number
M	Number of rows in the matrix
N	Number of columns in the matrix
B	Words 11 through 16 of 16_{10} -word matrix identification
NFILE	Number of end-of-file marks to be passed before writing starts. If 0, no file spacing takes place. If negative, backspacing occurs and NFILE end-of-file marks will be passed. Then, the tape will be spaced forward and past the last file mark encountered. The tape is always at the beginning of a file after any file spacing.
NMAT	Number of matrices to be passed before writing occurs. If 0, no matrix spacing takes place. A negative value is illegal, because backward spacing of matrices is not allowed. All matrix spacing takes place after file spacing is complete.
NTAPE	Logical tape number
IRROR	0 if successfully written; 1 if error occurs during file spacing; 2 if matrix spacing is negative; 3 if error occurs during matrix spacing

b. Space Required

Subroutine WRTETP requires 431 cells. Also, 134 cells of storage are required for subroutines FSR, FSF, and BSF.

c. Tape Format

The matrix consists of two FORTRAN logical records. The first of these is the 16_{10} -word identification, and the second consists of the matrix elements. The matrix may be written in fixed point, sparse, or null forms.

3. SUBROUTINE LISTINGS

This section contains the following subroutine listings.

Subroutine Page

READTP. 243

WRTETP 247

FVIO 252

FILE 254

INRPRD 255

FRUN. 257

The following is a description of subroutines FVIO, FILE, INRPRD, and FRUN:

Subroutine	Function
FVIO	This subroutine is the input/output statement specifying variable-output units 1 through 17.
FILE	The FILE definitions of units 1 through 17 are computed by this subroutine.
INRPRD	This subroutine computes the interproducts of two matrices.
FRUN	This is the subroutine that rewinds and unloads tapes.

SUBROUTINE READTP

```
$IBMAP READTP  300,M94/2,DECK
*READTP        SUBROUTINE TO READ A TL-01 BINARY TAPE
*              FROM A FORTRAN PROGRAM
*              CALL READTP (A,K,NAME,M,N,B,NFILE,NMAT,NTAPE,IRR)
*                          A = ADDRESS WHERE MATRIX IS TO BE STORED
*                          K = ROW DIMENSION STATEMENT ENTRY FOR A
*                          NAME = NAME OF MATRIX
*                          M = ROW SIZE OF MATRIX
*                          N = COLUMN SIZE OF MATRIX
*                          B = WORDS 5  THROUGH 16 OF TAPE ID
*                          NFILE = NUMBER OF FILES TO BE SPACED
*                                  FROM CURRENT POSITION
*                                  POSITIVE CAUSES FORWARD SPACE
*                                  NEGATIVE CAUSES BACKWARD SPACE
*                          NMAT = NUMBER OF MATRICES TO BE SPACED
*                                  FROM CURRENT POSITION
*                          NTAPE = LOGICAL TAPE NUMBER
*                          IRR = 0 IF READ IS SUCCESSFUL
*                              = 1 IF FILE SPACING ERROR
*                              = 2 IF MATRIX SPACING IS NEG.
*                              = 3 IF MATRIX SPACING ERROR
*                              = 4 IF CHECKSUM ERROR
*                              = 5 IF NAME ON TAPE IS WRONG
*
READTP SAVE    (1,2,4)I
       SXA     XR4,4
       STZ     TESTC2
       CLA*    5,4
       STO     TEMP1
       CLA*    11,4
       STO     TAPE
       CLA*    9,4
       TZE     RCDSP
       TPL     FSFILE
       SSP                   BACKSPACE
       SUB     =1
       STO     MFILE
       CALL    BSF(MFILE,TAPE,IRR1)
       TRA     TESTFL
FSFILE STO     MFILE
       CALL    FSF(MFILE,TAPE,IRR1)
TESTFL ZET     IRR1
       TRA     FILEER        FILE SPACING ERROR
RCDSP  LXA     XR4,4
       CLA*    10,4
       TZE     READID
       TMI     RCDER1
       ALS     1
       STO     MMAT          NUMBER OF LOGICAL RECORDS.
       CALL    FSR(MMAT,TAPE,IRR1)
       ZET     IRR1
       TRA     RCDER2        RECORD SPACING ERROR
READID CALL    .FVIO.(TAPE,TAPIB)
       CALL    .FRDB.(TAPIB)
       TSX     .FBLT.,4
       STO     CNAME
       LXA     XR4,2
```

```
        STO*   5,2            NAME                                      00000057
        TSX    .FBLT.,4                                                 00000058
        STO    CM                                                       00000059
        STO*   6,2            M                                         00000060
        TSX    .FBLT.,4                                                 00000061
        STO    CN                                                       00000062
        STO*   7,2            N                                         00000063
        TSX    .FBLT.,4                                                 00000064
        STO    CSUM           CHECKSUM                                  00000065
        AXT    12,1                                                     00000066
        CLA    8,2            B                                         00000067
        ADD    =12                                                      00000068
        STA    *+2                                                      00000069
  PNT1  TSX    .FBLT.,4                                                 00000070
        STO    **,1           LAST 12 NOS. INTO B                       00000071
        TIX    PNT1,1,1                                                 00000072
        LDQ    CM                                                       00000073
        MPY    CN                                                       00000074
        STQ    MTN                                                      00000075
        CALL   .FRLR.                                                   00000076
        CLA    TEMP1          NAME SUPPLIED BY CALLING PROGRAM          00000077
        TZE    NULOSP         IF IT IS ZERO, DO NOT CHECK               00000078
        SUB*   5,2            DO THE NAMES AGREE                        00000079
        TNZ    NAMEER         NO                                        00000080
NULOSP  CLA*   8,2                                                      00000081
        CAS    WDMSP                                                    00000082
        TRA    *+2                                                      00000083
        STO    TESTC2         MATRIX SPARSE                             00000084
READ    CALL   .FRDB.(TAPIB)                                            00000085
        AXT    1,2                                                      00000086
        LXA    XR4,4                                                    00000087
        CLA    3,4            A                                         00000088
        STA    REDE                                                     00000089
        CLA*   6,4                                                      00000090
        ALS    18                                                       00000091
        STD    TEST2          M                                         00000092
        STD    TEST4                                                    00000093
        STD    TEST6                                                    00000094
        CLA*   4,4            K                                         00000095
        PAC    0,1                                                      00000096
        SXD    TEST1-1,1                                                00000097
        SXD    TEST3-1,1                                                00000098
        SXD    TEST5-1,1                                                00000099
        XCA                                                             00000100
        MPY*   7,4            N                                         00000101
        XCA                                                             00000102
        PAC    0,1                                                      00000103
        SXD    TEST1,1        -K*N                                      00000104
        SXD    TEST3,1                                                  00000105
        SXD    TEST5,1                                                  00000106
        AXT    0,1                                                      00000107
        PXA    0,0                                                      00000108
*              START CHECKSUM OFF WITH NAME AND DIMENSIONS              00000109
        ACL    CNAME          NAME IN ADDRESS                           00000110
        ACL    CM             M IN ADDRESS                              00000111
        ACL    CN             N IN ADDRESS                              00000112
        SLW    TEMP           STORE SUM IN CELL FOR UPCOMING CHECKSUM   00000113
        NZT    TESTC2                                                   00000114
        TRA    REDEN                                                    00000115
        ACL    WDMSP                                                    00000116
        SLW     TEMP                                                    00000117
REDES   TSX     .FBLT.,4        SPARSE MATRIX                           00000118
        STO*    REDE                                                    00000119
        PDX     0,4                                                     00000120
        XCA                     GET LOGICAL VERSION FOR CKSUM           00000121
        XCL                                                             00000122
        ACL     TEMP                                                    00000123
        SLW     TEMP                                                    00000124
        TXL     *+3,4,0                                                 00000125
        AXT     0,4             STORE NO ZEROS                          00000126
        TRA     TEST3-1                                                 00000127
        CLA*    REDE                                                    00000128
        PAX     0,4                                                     00000129
STZRO   STZ*    REDE            STORE ZEROS                             00000130
        TXI     *+1,1,**        -K                                      00000131
TEST3   TXH     TIR4,1,**       -K*N                                    00000132
        PXD     0,2                                                     00000133
        PDC     0,1                                                     00000134
        TXI     *+1,2,1                                                 00000135
TEST4   TXL     TIR4,2,**       M                                       00000136
        TRA     RLR             TR TO RLR                               00000137
TIR4    TIX     STZRO,4,1                                               00000138
        TRA     REDES           READ NEXT WORD                          00000139
REDEN   TSX     .FBLT.,4        TEST FOR NULL MATRIX                    00000140
        NZT     MTN                                                     00000141
        TRA     RLR                                                     00000142
        STO*    REDE                                                    00000143
        LDQ*    REDE                                                    00000144
        SUB     WDMNL                                                   00000145
        TZE     *+3             NULL                                    00000146
        XCL                     NOT NULL                                00000147
        TRA     REDE1                                                   00000148
        XCL                                                             00000149
        ACL     TEMP                                                    00000150
        SLW     TEMP                                                    00000151
STZN    STZ*    REDE                                                    00000152
        TXI     *+1,1,**        -K                                      00000153
TEST5   TXH     STZN,1,**       -K*N                                    00000154
        PXD     0,2                                                     00000155
        PDC     0,1                                                     00000156
        TXI     *+1,2,1                                                 00000157
TEST6   TXL     STZN,2,**       M                                       00000158
        TRA     RLR                                                     00000159
        TSX     .FBLT.,4                                                00000160
REDE    STO     **,1            A                                       00000161
        XCA                     GET LEGICAL VERSION FOR CKSUM           00000162
        XCL                                                             00000163
REDE1   ACL     TEMP                                                    00000164
        SLW     TEMP                                                    00000165
        TXI     *+1,1,**        -K                                      00000166
TEST1   TXH     REDE-1,1,**     -K*N                                    00000167
        SXD     TEMP1,2                                                 00000168
        LDC     TEMP1,1                                                 00000169
        TXI     *+1,2,1                                                 00000170
TEST2   TXL     REDE-1,2,**     M                                       00000171
RLR     CALL    .FRLR.                                                  00000172
        CLA     CSUM                                                    00000173
        TZE     XR4             IF CSUM=0, DO NOT CHECK                 00000174
        SUB     =1.                                                     00000175
        TZE     XR4                                                     00000176
        CAL     CSUM
        ERA     TEMP
        TNZ     CSUMER
    XR4 AXT     **,4
        STZ*    12,4           ZERO ERROR CODE
        RETURN  READTP
 FILEER CLA     =1             FILE SPACING ERROR
        LXA     XR4,4
        STO*    12,4
        RETURN  READTP
 RCDER1 CLA     =2             NEGATIVE MATRIX SPACING
        TRA     FILEER+1
 RCDER2 CLA     =3             MATRIX SPACING ERROR
        TRA     FILEER+1
 CSUMER CLA     =4             CHECKSUMS DO NOT AGREE
        TRA     FILEER+1
 NAMEER CLA     =5             NAMES DO NOT AGREE
        TRA     FILEER+1
  WDMNL BCI     1,M=NULL
  WDMSP BCI     1,SPARSE
 TESTC2 PZE
  MTN   PZE
   TAPE HTR     0
   IRR1 HTR     0
   TEMP HTR     0
  TEMP1 HTR     0
  CSUM  HTR     0
  MFILE HTR     0
  MMAT  HTR     0
  CNAME PZE     0
     CM PZE     0
     CN PZE     0
  TAPIB PZE                    TAPE FOR IBSYS
        END
```

SUBROUTINE WRTETP

```
$IBMAP WRTETP  400,M94/2,DECK
*WRTETP        SUBROUTINE TO WRITE A TL-01 BINARY TAPE
*              FROM A FORTRAN PROGRAM.
*              CALL WRTETP (A,K,NAME,M,N,B,NFILE,NMAT,NTAPE,IRR)
*                          A = ADDRESS OF MATRIX (1,1) ELEMENT
*                          K= ROW DIMENSION STATEMENT ENTRY FOR A
*                          NAME = NAME OF MATRIX
*                          M = ROW SIZE OF MATRIX
*                          N=COLUMN SIZE OF MATRIX
*                          B=WORDS 11 THROUGH 16 OF ID
*                          NFILE=NUMBER OF FILES TO BE SPACED
*                                FROM CURRENT POSITION
*                                POSITIVE CAUSES FORWARD SPACE
*                                NEGATIVE CAUSES BACKWARD SPACE
*                          NMAT=NUMBER OF MATRICES TO BE SPACED
*                                FROM CURRENT POSITION
*                          NTAPE=LOGICAL TAPE NUMBER
*                          IRR= 0 IF SUCCESSFUL WRITE
*                                = 1 IF ERROR ON FILE SPACE
*                                = 2 IF MATRIX SPACING IS NEGATIVE
*                                = 3 IF ERROR ON MATRIX SPACE
*
WRTETP SAVE    (1,2,4)I
       SXA     XR4,4
       CLA*    11,4          NTAPE
       STO     TAPE
       CLA*    9,4           NFILE
       TZE     RCDSP
       TPL     FSFILE
       SSP                   BACKSPACE
       SUB     =1
       STO     MFILE
       CALL    BSF(MFILE,TAPE,IRR1)
       TRA     TESTFL
FSFILE STO     MFILE
       CALL    FSF(MFILE,TAPE,IRR1)
TESTFL ZET     IRR1
       TRA     FILEER        FILE SPACING ERROR
RCDSP  LXA     XR4,4
       CLA*    10,4          NMAT
       TZE     CALCSM
       TMI     RCDER1
       ALS     1
       STO     MMAT          NUMBER OF LOGICAL RECORDS.
       CALL    FSR(MMAT,TAPE,IRR1)
       ZET     IRR1
       TRA     RCDER2        RECORD SPACING ERROR
CALCSM LXA     XR4,4
       STZ     TESTC1
       STZ     TESTC2
       CLA     WDSPSE
       STO     TESTC3
*              TESTC3=SPARSE,MATRIX SPARSE
*              TESTC3=0,MATRIX NOT SPARSE
       CLA*    3,4
       CAS     WDMNL         TEST ELEMENT A(1,1)
       TRA     *+2
```

```
        STO     TESTC1          ELEMENT A(1,1) =M=NULL                      00000057
        CLA     3,4                                                         00000058
        STA     CSM1                                                        00000059
        CLA*    6,4                                                         00000060
        SLW     CM              SAVE M IN ADDRESS                           00000061
        ALS     18                                                          00000062
        STD     TST2                                                        00000063
        STD     TST4                                                        00000064
        STD     TST6                                                        00000065
        STD     TST8                                                        00000066
        CLA*    4,4             K                                           00000067
        PAC     0,1                                                         00000068
        SXD     TST1-1,1                                                    00000069
        SXD     TST3-1,1                                                    00000070
        SXD     TST5-1,1                                                    00000071
        SXD     TST7-1,1                                                    00000072
        XCA                                                                 00000073
        MPY*    7,4             K*N                                         00000074
        XCA                                                                 00000075
        PAC     0,1                                                         00000076
        SXD     TST1,1                                                      00000077
        SXD     TST3,1                                                      00000078
        SXD     TST5,1                                                      00000079
        SXD     TST7,1                                                      00000080
        AXT     0,1                                                         00000081
        AXT     1,2                                                         00000082
        CLA*    5,4             NAME                                        00000083
        STO     CNAME           NAME IN ADDRESS                             00000084
        CAL*    7,4             N                                           00000085
        SLW     CN              N IN ADDRESS                                00000086
        ACL     CNAME           START CHECKSUM OFF WITH NAME AND DIMENSIONS00000087
        ACL     CM                                                          00000088
        SLW     TEMP                                                        00000089
        LDQ     CN                                                          00000090
        MPY     CM                                                          00000091
        STQ     MTN                                                         00000092
        NZT     MTN                                                         00000093
        TRA     PTWT1-1                                                     00000094
        ZET     TESTC1          IS A(1,1) = M=NULL                          00000095
        TRA     NULLCS          NULL MATRIX                                 00000096
        CAL     TEMP                                                        00000097
CSM1    ACL     **,1            A                                           00000098
        XCL                                                                 00000099
        CLA*    CSM1                                                        00000100
        TZE     GCKSMB                                                      00000101
        STO     TESTC2          MATRIX NOT NULL                             00000102
        ANA     =O377400000000                                              00000103
        TNZ     *+2                                                         00000104
        STZ     TESTC3          MATRIX NOT SPARSE                           00000105
GCKSMB  XCL                                                                 00000106
        TXI     *+1,1,**        -K                                          00000107
TST1    TXH     CSM1,1,**       -K*N                                        00000108
        SXD     TEMP,2                                                      00000109
        LDC     TEMP,1                                                      00000110
        TXI     *+1,2,1                                                     00000111
TST2    TXL     CSM1,2,**       M                                           00000112
        SLW     TEMP                                                        00000113
        CLA     TESTC2                                                      00000114
        TMI     PTWT                                                        00000115
        TNZ     PTWT                                                        00000116
```

```
NULLCS CAL     WDMNL                 NULL MATRIX                                00000117
       SLW     TESTC1                                                           00000118
       ACL     CN                                                               00000119
       ACL     CM                                                               00000120
       ACL     CNAME                                                            00000121
       SLW     TEMP                  NULL MATRIX CHECK SUM                      00000122
       STZ     TESTC3                                                           00000123
       TRA     PTWT1                                                            00000124
 PTWT  NZT     TESTC3                                                           00000125
       TRA     PTWT1                                                            00000126
       AXT     0,1                   SPARSE MATRIX                              00000127
       AXT     1,2                                                              00000128
       AXT     0,4                   0 COUNT                                    00000129
       PXA     0,0                                                              00000130
 FIXSP ZET*    CSM1                                                             00000131
       TRA     CKWC                                                             00000132
       TXI     *+1,4,1               ADD 1 TO ZERO COUNT                        00000133
       SXA     SPIR,1                ELEMENT LOC.                               00000134
       TXI     *+1,1,**              -K                                         00000135
 TST5  TXH     FIXSP,1,**            -K*N                                       00000136
       SXD     TEMP,2                                                           00000137
       LDC     TEMP,1                                                           00000138
       TXI     *+1,2,1                                                          00000139
 TST6  TXL     FIXSP,2,**            M                                          00000140
       SLW     TEMP                                                             00000141
       PXA     0,4                                                              00000142
       TZE     *+3                                                              00000143
       LXA     SPIR,1                                                           00000144
       STO*    CSM1                  STORE 0 COUNT                              00000145
       ACL     TEMP                  FORM SPARSE CHECK SUM                      00000146
       ACL     CN                                                               00000147
       ACL     CNAME                                                            00000148
       ACL     CM                                                               00000149
       ACL     WDSPSE                                                           00000150
       SLW     TEMP                                                             00000151
       TRA     PTWT1                                                            00000152
 CKWC  ACL*    CSM1                                                             00000153
       TXH     *+2,4,0               ANY ZEROES YET                             00000154
       TRA     TST5-2                                                           00000155
       SLW     TEMP                                                             00000156
       SXD     SPIR,1                LOC. NON-ZERO TERM AFTER COUNT             00000157
       LXA     SPIR,1                LAST ZERO ELEM. LOC.                       00000158
       PXA     0,4                                                              00000159
       STO*    CSM1                  STORE CONTROL WORD                         00000160
       ACL     TEMP                  UPDATE CHECKSUM                            00000161
       LXD     SPIR,1                                                           00000162
       AXT     0,4                   ZERO COUNT=0                               00000163
       TRA     TST5-2                                                           00000164
       STZ     TESTC3                                                           00000165
 PTWT1 CALL    .FVIO.(TAPE,TAPIB)                                               00000166
       CALL    .FWRB.(TAPIB)                                                    00000167
       CLA     CNAME                                                            00000168
       TSX     .FBLT.,4              NAME                                       00000169
       CLA     CM                                                               00000170
       TSX     .FBLT.,4              M                                          00000171
       CLA     CN                                                               00000172
       TSX     .FBLT.,4              N                                          00000173
       CLA     TEMP                                                             00000174
       TSX     .FBLT.,4              CHECKSUM                                   00000175
       CLA     TESTC3                                                           00000176
       TSX    .FBLT.,4       SPARSE OR 0
       AXT    5,1
       CLA    =0
       TSX    .FBLT.,4       5 CONSECUTIVE ZEROES
       TIX    *-2,1,1
       LXA    XR4,4
       AXT    6,1
       CLA    8,4            B
       ADD    =6
       STA    *+1
       CLA    **,1           ADDRESS B+6
       TSX    .FBLT.,4       6 NUMBERS OF B
       TIX    *-2,1,1
       CALL   .FWLR.
       CALL   .FWRB.(TAPIB)
       NZT    MTN
       TRA    CKWZR
       NZT    TESTC1
       TRA    NWRTE          MATRIX NOT NULL
       CLA    TESTC1         M=NULL
       TSX    .FBLT.,4
       AXT    15,1
       CLA    =0
       TSX    .FBLT.,4
       TIX    *-2,1,1
       TRA    WLR
NWRTE  AXT    0,1
       AXT    1,2
       NZT    TESTC3
       TRA    WRTE           MATRIX NOT SPARSE
       AXT    0,4            NUMBER OF WORDS COUNT
SPWRTE CLA*   CSM1
       TZE    TST7-1
       ANA    =0377400000000
       LDQ*   CSM1
       TNZ    *+2            NOT CONTROL WORD
       STZ*   CSM1           ZERO OUT CONTROL WORD
       XCA
       SXD    TEMP,4
       TSX    .FBLT.,4
       LXD    TEMP,4
       TXI    *+1,4,1
       TXI    *+1,1,**       -K
TST7   TXH    SPWRTE,1,**    -K*N
       SXD    TEMP,2
       LDC    TEMP,1
       TXI    *+1,2,1
TST8   TXL    SPWRTE,2,**    M
       PXA    0,4
       SUB    =16
       TPL    WLR            MORE THAN 16 WORDS
       SSP
       TRA    WRZR
*             WRITE FIXED POINT MATRIX
WRTE   CLA*   CSM1           CHECKSUM CORRECT
       TSX    .FBLT.,4
       TXI    *+1,1,**       -K
TST3   TXH    WRTE,1,**      -K*N
       SXD    TEMP,2
       LDC    TEMP,1
```

```
        TXI     *+1,2,1                                               00000237
  TST4  TXL     WRTE,2,**        M                                    00000238
 CKWZR  CLA     =16                                                   00000239
        SUB     MTN                                                   00000240
        TMI     WLR                                                   00000241
        TZE     WLR                                                   00000242
 WRZR   PAX     0,1              M*N LESS THAN 16                     00000243
        CLA     =0                                                    00000244
        TSX     .FBLT.,4                                              00000245
        TIX     *-2,1,1                                               00000246
 WLR    CALL    .FWLR.                                                00000247
   XR4  AXT     **,4                                                  00000248
        STZ*    12,4                                                  00000249
        RETURN  WRTETP                                                00000250
FILEER  CLA     =1               FILE SPACING ERROR                   00000251
        LXA     XR4,4                                                 00000252
        STO*    12,4                                                  00000253
        RETURN  WRTETP                                                00000254
RCDER1  CLA     =2               NEGATIVE MATRIX SPACING              00000255
        TRA     FILEER+1                                              00000256
RCDER2  CLA     =3               MATRIX SPACING ERROR                 00000257
        TRA     FILEER+1                                              00000258
 WDMNL  BCI     1,M=NULL                                              00000259
WDSPSE  BCI     1,SPARSE                                              00000260
TESTC1  PZE                                                           00000261
TESTC2  PZE                                                           00000262
TESTC3  PZE                                                           00000263
SPIR    PZE                                                           00000264
 MTN    PZE                                                           00000265
  TEMP  HTR     0                                                     00000266
 MFILE  HTR     0                                                     00000267
 MMAT   HTR     0                                                     00000268
  IRR1  HTR     0                                                     00000269
  TAPE  HTR     0                                                     00000270
 CNAME  PZE     0                                                     00000271
    CM  PZE     0                                                     00000272
    CN  PZE     0                                                     00000273
TAPIB   PZE                      TAPE FOR IOCS                        00000274
        END                                                           00000275
```

SUBROUTINE FVIO

```
$IBMAP FVIO    50,()OK,DECK
       TTL     FVIO - FORTRAN VARIABLE I/O LOGICAL UNIT                  3FA00020
       REM                                                               3FA00030
       REM     CALLING SEQUENCE IS CALL .FVIO.(LN,ERAS) WHERE LN IS      3FA00040
       REM     LOCATION OF VARIABLE LOGICAL UNIT AND ERAS WILL CONTAIN   3FA00050
       REM     CONTENTS OF APPROPRIATE .UNXX.  (.UNXX. CONTAINS          3FA00060
       REM     PZE UNITXX WHERE XX CORRESPONDS TO LOGICAL UNIT N).       3FA00070
       REM     FVIO IS CALLED FOR ANY I/O STATEMENT SPECIFYING           3FA00080
       REM     A VARIABLE LOGICAL UNIT.                                  3FA00090
       REM                                                               3FA00100
.FVIO. SAVE    (2)                                                    (1)3FA00110
       CLA*    3,4                    PICK UP LOGICAL UNIT NUMBER     (1)3FA00120
       PAC     ,2                                                     (1)3FA00130
       TXL     ERROR,2,-NUNITS-1      IS UNIT ZERO, OR TOO LARGE      (1)3FA00140
       CLA*    TABLE,2                SAVE ADDRESS OF                 (1)3FA00150
       STO*    4,4                    FILE CONTROL BLOCK              (1)3FA00160
       RETURN  .FVIO.                                                 (1)3FA00170
ERROR  CLA*    3,4                    LOGICAL UNIT IN ERROR           (1)3FA00250
       ANA     ADMSK                  DEFINED FOR THIS UNIT VALUE.       3FA00260
       XCA                            CONVERT THIS ILLEGAL VALUE         3FA00270
       AXT     0,4                    TO DECIMAL FOR ERROR MESSAGE.      3FA00280
       STZ     TEMP                                                      3FA00290
CNVT   PXA     0,0                                                       3FA00300
       DVP     L(10)                                                     3FA00310
       ALS     0,4                                                       3FA00320
       ORS     TEMP                                                      3FA00330
       CLA     =1                                                        3FA00340
       TLQ     *+2                                                       3FA00350
       TXI     CNVT,4,-6                                                 3FA00360
       CAL     BLANKS                                                    3FA00370
       ALS     6,4                                                       3FA00380
       ORA     TEMP                                                      3FA00390
       SLW     E47MES+6                                                  3FA00400
UNERR  CALL    .FXEM.(CODE)           EXIT FOR EXECUTION ERROR.          3FA00410
       TRA     .LXERR                 NO OPTIONAL EXIT.                  3FA00420
CODE   PZE     47                                                        3FA00430
ER47MS PZE     E47MES,,7                                                 3FA00440
ER47OP PZE     NOOPXT,,7                                                 3FA00450
E47MES BCI     7,0LOGICAL UNIT NOT DEFINED FOR VALUE                     3FA00460
NOOPXT BCI     7,0NO OPTIONAL EXIT - EXECUTION TERMINATED                3FA00470
ADMSK  OCT     000000077777                                              3FA00480
TEMP   PZE     **                                                        3FA00490
L(10)  DEC     10                                                        3FA00500
BLANKS BCI     1,                                                        3FA00510
TABLE  PZE     NUNITS                                                    3FA00550
       PZE     .UN01.                                                    3FA00560
       PZE     .UN02.                                                    3FA00570
       PZE     .UN03.                                                    3FA00580
       PZE     .UN04.                                                    3FA00590
       PZE     .UN05.                                                    3FA00600
       PZE     .UN06.                                                    3FA00610
       PZE     .UN07.                                                    3FA00620
       PZE     .UN08.                                                    3FA00630
       PZE     .UN09.
       PZE     .UN10.
       PZE     .UN11.
       PZE     .UN12.
       PZE     .UN13.
       PZE     .UN14.
       PZE     .UN15.
       PZE     .UN16.
       PZE     .UN17.
*      ADDITIONAL UNITS MAY BE INSERTED HERE. FOR EACH UNIT             3FA00640
*      INSERTED, A CORRESPONDING ROUTINE MUST BE INSERTED TO            3FA00650
*      PRODUCE A $FILE CARD FOR THE ADDITIONAL UNIT,                    3FA00660
NUNITS EQU     *-TABLE-1                                                3FA00670
       END                                                              3FA00680
```

SUBROUTINE FILE

```
$IBMAP FILE    DECK
       ENTRY   .UN01.
       ENTRY   .UN02.
       ENTRY   .UN03.
       ENTRY   .UN04.
       ENTRY   .UN07.
       ENTRY   .UN08.
       ENTRY   .UN09.
       ENTRY   .UN10.
       ENTRY   .UN11.
       ENTRY   .UN12.
       ENTRY   .UN13.
       ENTRY   .UN14.
       ENTRY   .UN15.
       ENTRY   .UN16.
       ENTRY   .UN17.
.UN01. PZE     UNIT01
.UN02. PZE     UNIT02
.UN03. PZE     UNIT03
.UN04. PZE     UNIT04
.UN07. PZE     UNIT07
.UN08. PZE     UNIT08
.UN09. PZE     UNIT09
.UN10. PZE     UNIT10
.UN11. PZE     UNIT11
.UN12. PZE     UNIT12
.UN13. PZE     UNIT13
.UN14. PZE     UNIT14
.UN15. PZE     UNIT15
.UN16. PZE     UNIT16
.UN17. PZE     UNIT17
UNIT01 FILE    ,UT1,READY,INOUT,BIN,SCRATCH
UNIT02 FILE    ,UT2,READY,INOUT,BIN,SCRATCH
UNIT03 FILE    ,UT3,READY,INOUT,BIN,SCRATCH
UNIT04 FILE    ,UT4,READY,INOUT,BIN,SCRATCH
UNIT07 FILE    ,PP1,READY,OUTPUT,BLK=14,BCD,PUNCH
UNIT08 FILE    ,C(1),READY,INOUT,BIN,SCRATCH
UNIT09 FILE    ,LB4,READY,INOUT,MXBCD,SCRATCH
UNIT10 FILE    ,C(2),READY,INOUT,BIN,SCRATCH
UNIT11 FILE    ,C(3),READY,INOUT,BIN,SCRATCH
UNIT12 FILE    ,C(4),READY,INOUT,BIN,SCRATCH
UNIT13 FILE    ,C(5),READY,INOUT,BIN,SCRATCH
UNIT14 FILE    ,B(1),READY,INOUT,BIN,SCRATCH
UNIT15 FILE    ,B(2),READY,INOUT,BIN,SCRATCH
UNIT16 FILE    ,A(1),READY,INOUT,BIN,SCRATCH
UNIT17 FILE    ,A(2),READY,INOUT,BIN,SCRATCH
       END
```

SUBROUTINE INRPRD

```
$IBMAP INRPRD  60,M94,DECK
*INRPRD        SUBROUTINE TO COMPUTE AN INNER PRODUCT      (7094/2 ONLY)
*
*              CALL INRPRD (A,INCRMA,B,INCRMB,PROD,N)
*              A = STARTING ADDRESS OF ROW
*              INCRMA = STORAGE INCREMENT FOR ELEMENTS OF A
*              B = STARTING ADDRESS OF COLUMN
*              INCRMB = STORAGE INCREMENT FOR ELEMENTS OF B
*              PROD = LOCATION WHERE PRODUCT IS TO BE STORED
*              PRDSUM ENTRY ADDS THE RESULT TO THE PROD CELL
*              N = NUMBER OF ELEMENTS IN ROW OR COLUMN
*
       ENTRY   PRDSUM
*
INRPRD SAVE    (1,2,4)I
       CAL     IN            FIND OUT WHERE TO GO
       TNZ     PRDSUM+2      IF NON-ZERO, ENTRY WAS AT PRDSUM
       TRA     BEGIN-2
PRDSUM STL     IN            SAVE ENTRY LOCATION
       TRA     INRPRD
       CAL     ADD           STUFF FOR SUMMING WITH RESULT CELL
       SLW     SUM1
       TRA     BEGIN
       CAL     NOADD         STUFF FOR SIMPLE INNER PRODUCT
       SLW     SUM1
BEGIN  SXA     XR4,4
       CAL     3,4           PRE-MULT
       STA     OVER
       CAL     5,4           POST-MULT
       STA     OVER+1
       CLA*    4,4           PRE-MULT. INCREMENT
       PAC     0,2            NEGATIVE OF INCREMENT FOR A
       SXD     LOOPND-2,2
       CLA*    6,4           POST-MULT. INCREMENT
       PAC     0,2            NEGATIVE OF INCREMENT FOR B
       SXD     LOOPND-1,2
       AXT     0,1           CONTROL FOR A
       AXT     0,2           CONTROL FOR B
       CLA*    8,4           N
       PAX     0,4           CONTROL FOR NUMBER OF ELEMENTS
START  STZ     TEMPAD        CLEAR SUMMING CELL
       STZ     TEMPAD+1
  OVER LDQ     **,1          A
       FMP     **,2          B
       DFAD    TEMPAD
       DST     TEMPAD
       TXI     *+1,1,**      -INCRMA IN DECREMENT
       TXI     *+1,2,**      -INCRMB IN DECREMENT
LOOPND TIX     OVER,4,1
   XR4 AXT     **,4
  SUM1 HTR     9,4           THIS SHOULD ALWAYS BE STUFFED
       FRN
       STO*    7,4           INNER PRODUCT
       STZ     IN
       RETURN  INRPRD
IN     PZE     0             FLAG FOR ENTRY POINT
TEMPAD BSS     2             TEMPORARY STORAGE FOR D.P. SUMMING
```

```
NOADD TRA     SUM1+1        USED FOR INRPRD ENTRY                          00000057
  ADD FAD*    7,4           USED FOR PRDSUM ENTRY                          00000058
      END                                                                  00000059
```

SUBROUTINE FRUN

```
$IBMAP FRUN    50,LIST,DECK,M94/2                                       RUN00010
*                                                                       RUN00040
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * RUN00050
*                                                                       RUN00060
*      CALL UNLOAD (LTAPE)                                              RUN00070
*           LTAPE = LOGICAL TAPE NUMBER                                 RUN00080
*                                                                       RUN00090
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * RUN00100
*                                                                       RUN00110
       LDIR                                                             RUN00120
UNLOAD SAVE    4,I                                                      RUN00130
       CLA*    3,4           LOGICAL NUMBER                             RUN00140
       STO     TEMP                                                     RUN00150
       CALL    .FVIO.(TEMP,TEMP+1)                                      RUN00160
       LAC     TEMP+1,4                                                 RUN00170
       SCA     SETB,4                                                   RUN00190
RUN    TSX     .CLOSE,4                                                 RUN00250
SETB   PZE     **                                                       RUN00260
NOP    RETURN  UNLOAD                                                   RUN00270
       LORG                                                             RUN00280
ERASE  CONTRL  ER                                                       RUN00290
       USE     ER                                                       RUN00300
TEMP   BSS     2                                                        RUN00310
       BSS     18                                                       RUN00320
       END                                                              RUN00330
```

APPENDIX III

PHASE I PROGRAM LISTING

This appendix contains the following listings:

Subroutine	Page
PHASE I MAIN PROGRAM	261
MAST	265
PAGHED	269
UNPACK	270
PRINT	271
SUBM1	272
GENRAT	273
REDUCE	274
INFO	275
PLATE	278
MUL1	284
MUL2	285
PSTIF	286
QUAD	287
LAMK	289
KLAMT	290
TRI	291
INP	293
INPM	294
INPST	297
OUTP	299
OUTPM	300
OUTPSH	301
COMBIN	303
STORE	304
MOVE	306
PMTR	307
SMTR	309
LOCAL	312
COPLAN	314
BEAM	315
TINVR	323
SMULT	325
MULT	326
SBMTR	327
SSTIF	329
MAD	331
SBGS	332
OFST	333
CSTIF	334
CBMTR	337
MERGE	340
SOR	341
MERGBC	342

Subroutine Page

STRESS 351
MSTRES 352
SOLN 354
TEST 355
FKSORT 356
KFFSRT 359
CONECT 363
EXPAND 365
EXTRAN 367
DELETE 370
SSORT 374
FREMOD 378
VALVCT 383
HESSEN 384
QRITER 385
SORTRT 387
VECTOR 388
TRANS1 389
TRANS2 390
AMERGE 391
SMERGE 393
PHASE I TLO1 DATA LISTING 396

PHASE I PROGRAM LISTING

PHASE I – MAIN PROGRAM

SUBROUTINE PHASE1

```
$IBFTC PHASE1  DECK
C           ****************************************************
C          *                                                     *
C         *RANDOM VIBRATION ANALYSIS SYSTEM FOR COMPLEX STRUCTURES*
C          *                                                    *
C           *                (  R A N V I B  )                 *
C             **************************************************
C
C                            P  H  A  S  E     1
C
C   MAIN PROGRAM - THE EIGENVALUE EIGENVECTORS (FREMOD ROUTINE) AND THE
C                  STRUCTURAL ANALYSIS PROGRAM (MAST) IS CALLED IN THIS
C                  PROGRAM.
C
C
C
C                ***TAPE USAGE***
C                                NTAP10-OUTPUT TAPE. THE FOLLOWING ITEMS
C                                       ARE STORED ON THIS TAPE.
C                                     * * * * * * * * * * *
C                                     * STIFFNESS         *
C                                     * FLEXIBILITY       *
C                                     *            *EOF   *
C                                     * STRESS(PLATES)    *
C                                     *                   *
C                                     * STRESS(BEAMS)     *
C                                     *            *EOF   *
C                                     * FREQUENCIES       *
C                                     * MODE SHAPES       *
C                                     * GENERALIZED MASS  *
C                                     *            *EOF   *
C                                     * MASS(CARD INPUT)  *
C                                     *            *EOF   *
C                                     *                   *
C                                     *                   *
C                                     * * * * * * * * * * *
C
C
C
C
C                                 NTAP2-  MAST OUTPUT. THE FOLLOWING
C                                       ITEMS ARE STORED ON THIS TAPE.
C                                     * * * * * * * * * * * * *
C                                     * PARAMETER MATRIX      *
C                                     *                 *EOF  *
C                                     * STIFFNESS MATRIX      *
C                                     *                 *EOF  *
C                                     * FLEXIBILITY MATRIX    *
C                                     *                 *EOF  *
C                                     * * * * * * * * * * *
C
C
C                                 NTAP8-  MAST OUTPUT. THE FOLLOWING
C                                       ITEMS ARE STORED ON THIS TAPE.
C                                     * * * * * * * * * * * * *
C                                     * PARAMETER MATRIX      *
C                                     *                 *EOF  *
```

```
C                                      * STRESS(BEAMS)          *
C                                      *                 *EOF   *
C                                      *                        *
C                                      * * * * * * * * * * * * *
C
C
C
C                                 NTAP12-  MAST OUTPUT. THE FOLLOWING
C                                         ITEMS ARE STORED ON THIS TAPE.
C                                       * * * * * * * * * * * * *
C                                       * PARAMETER MATRIX       *
C                                       *                 *EOF   *
C                                       * STRESS(PLATES)         *
C                                       *                 *EOF   *
C                                       *                        *
C                                       * * * * * * * * * * * * *
C
C
C
C                            IF FLG2=0  STRESSES ARE NOT CALCULATED
C                                   =1  STRESSES FOR PLATES ONLY
C                                   =2  STRESSES FOR BEAMS ONLY
C                                   =3  STRESSES FOR PLATES AND BEAMS
C
C                            IF FLG1=0       MAST AND FREMOD ROUTINES
C                               FLG1 NOT 0   FREMOD ROUTINE ONLY
C
C
C
C
      COMMON/PRNT/NPRNTK,NSTRSP,NSTRSB
      INTEGER FLG1,FLG2
      NTAP1 = 10
      NTAP2 = 2
      NTAP8 = 8
      NTAP12 = 12
      REWIND NTAP1
      REWIND NTAP2
      REWIND NTAP8
      REWIND NTAP12
C
C*** READ IN THE CONTROL CARD
      READ(5,9000) FLG1,FLG2,NPRNTK,NSTRSP,NSTRSB
C
C*** IF FLG1 IS NOT EQUAL TO 0, THEN ONLY THE EIGENVALUE-EIGENVECTOR
C    ROUTINE IS CALLED.  OTHERWISE, THE MAST ROUTINE IS ALSO CALLED.
      IF( FLG1 .NE. 0 ) GO TO 50
C
C*** THE MAST PROGRAM CALCULATES THE STIFFNESS, FLEXIBILITY AND
C    STRESS MATRICES.
C     ******************************************************************
      CALL MAST
C
      REWIND NTAP1
C***                          MERGE THE STIFFNESS MATRIX
      NFILE = 1
C     ******************************************************************
      CALL AMERGE( NTAP2, NTAP1, NFILE )
C
C***                          MERGE THE FLEX MATRIX
```

```
      NFILE = 2
C     ******************************************************************
      CALL AMERGE( NTAP2, NTAP1, NFILE )
      END FILE NTAP1
C
C
      IF ( FLG2 .EQ. 0 ) GO TO 45
      GO TO (10,20,10), FLG2
C
C*** MERGE THE STRESS MARICES FOR PLATES AND REPARTITION TO 8XN
 10   ITYPE = 8
C     ******************************************************************
      CALL SMERGE( NTAP8,NTAP1,ITYPE )
      IF( FLG2 .EQ. 3 ) GO TO 20
      GO TO 45
C
C*** MERGE THE STRESS MATRICES FOR BEAMS AND REPARTITION TO 6XN
 20   ITYPE = 6
C     ******************************************************************
      CALL SMERGE( NTAP12,NTAP1,ITYPE )
C
C***FREMOD PROGRAM IS CALLED TO FIND THE EIGENVALUES(FREQUENCIES),
C                    EIGENVECTORS(MODE SHAPES) AND GENERALIZED MASSES.
C
C
 45   END FILE NTAP1
C
C     ******************************************************************
 50   CALL FREMOD
C
 9000 FORMAT(5I10)
      RETURN
      END
```

```
$IBFTC BLK      DECK
       BLOCK DATA                                                        021
       COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
       DATA MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,MT13,MT14,
     * MT15,MT16,MT17/1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17/
       COMMON/REDUC/NTEST,NTEST2
       DATA NTEST/6HAND ST/,NTEST2/6HONLY  /
       END                                                               029
```

SUBROUTINE MAST

```
$IBFTC MAST*    DECK
      SUBROUTINE MAST
C
C
C
C     PROGRAM CONTROL PARAMETERS
C     0  NO EXECUTION
C     1  EXECUTION
C     2  PRINT
C
C     NP=0  (60*60 PARTITIONS)
C     IF NVIB EQUALS 1 PARTITIONS ARE PRINTED
C
      COMMON/RENT/NRENT,KRENT
      COMMON/MAPSTR/IPTOT,IBTOT
      COMMON/CONT1/JPART(800)
      COMMON/LASTND/LN(200)
      COMMON/COMS/NSIZE(200)
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP,NOPT(4)
      COMMON/CONTRL/NDEFL,NKSP,NREX,NNF,NPSTR,NBSTR,NVIB,IF88
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/TITL/TITLE(13)
      COMMON/PAGE/NPAGE
      COMMON/REDUC/NTEST,NTEST2
      DIMENSION IERROR(5)
      INTEGER FRPR,SRP,SRB,FR
C
C SET ALL OPTIONS JO ZERO
      NDEFL = 0
      NKSP = 0
      NREX = 0
      NNF = 0
      NBSTR = 1
      NPSTR = 1
      IF88 = 0
      NCOND = 0
    1 NPS=0
      NTOL=0
      NPAGE=0
      DO 5 I=1,5
      IERROR(I) = 0
    5 CONTINUE
      REWIND MT2
      REWIND MT4
      REWIND MT8
      REWIND MT11
      REWIND MT12
      REWIND MT1
      REWIND MT3
      REWIND MT16
      IN = MT5
      IOUT = MT6
C
      READ(IN,9000)TITLE
C
      READ (IN,9101) NOPT,NVIB,KRPR,FRPR,SRP,SRB,FR
      CALL PAGHED
      WRITE (IOUT,9001) NOPT
      READ(IN,9100)NBEAM,NPLATE,NNODE,NP
      WRITE(IOUT,9002)NBEAM,NPLATE,NNODE,NP
      IF (NOPT(3) .EQ. NTEST) GO TO 10
      IF (NOPT(3) .EQ. NTEST2) GO TO 10
      GO TO 99                                                          107
C
   10 CONTINUE
      CALL SUBM1                                                        108
C                                                                       109
      CALL SOLN                                                         111

C
C***** THIS SECTION CONTROLS THE EXECUTION OF THE TL01 DATA PHASES.
C
      REWIND MT9
      AREA = 1.0

C SPACE TAPE PAST FIRST FILE CONTAINING FORTRAN GENERATION ROUTINES
      I=1
   50 CONTINUE
      CALL FSF(1,MT9,IER)
      IF(IER .NE. 0) GO TO 900

C EXECUTE A.TL01 PHASE (WHEN I=1, KR WILL BE COMPUTED)
      CALL TL01(MT9,0,IERROR)
      DO 55 ICELL=1,5
      IF(IERROR(ICELL) .NE. 0) GO TO 999
   55 CONTINUE

C TRANSFER TO APPROPRIATE TEST TO DETERMINE NEXT TL01 PHASE TO BE EXECUTED.
      GO TO (100,200,300,400,500,600,700,800),I
  100 CONTINUE

C IS PRINTING OF KR DESIRED
      IF(KRPR .EQ. 0) GO TO 150

C PRINT KR
      I = 2
      GO TO 50

C NO PRINT OF KR
  150 CONTINUE
      AREA = 2.0
      CALL FSF(1,MT9,IER)
      IF(IER .NE. 0) GO TO 900

C IS FR DESIRED
  200 CONTINUE
      IF(FR .NE. 0) GO TO 250
      I = 3
      GO TO 50

C NO FR DESIRED
  250 CONTINUE
      AREA = 3.0
      CALL FSF(2,MT9,IER)
      IF(IER .NE. 0) GO TO 900
      GO TO 400
```

```
C IS PRINT OF FR DESIRED
  300 CONTINUE
      IF(FRPR .EQ. 0) GO TO 350
      I = 4
      GO TO 50

C NO PRINT OF FR DESIRED
  350 CONTINUE
      AREA = 4.0
      CALL FSF(1,MT9,IER)
      IF(IER .NE. 0) GO TO 900

C ARE STRESSES DESIRED
  400 CONTINUE
      IF(NOPT(3) .NE. NTEST) GO TO 800
      IF(NPLATE .EQ. 0) GO TO 450
      I = 5
      GO TO 50

C NO PLATES
  450 CONTINUE
      AREA = 5.0
      CALL FSF(2,MT9,IER)
      IF(IER .NE. 0) GO TO 900
      GO TO 600

C IS PRINT OF PLATE STRESS DESIRED
  500 CONTINUE
      IF(SRP .EQ. 0) GO TO 550
      I = 6
      GO TO 50

C NO PRINT OF PLATE STRESSES
  550 CONTINUE
      AREA = 6.0
      CALL FSF(1,MT9,IER)
      IF(IER .NE. 0) GO TO 900

C ANY BEAMS
  600 CONTINUE
      IF(NBEAM .EQ. 0) GO TO 800
      I = 7
      GO TO 50

C IS PRINT OF BEAM STRESSES DESIRED
  700 CONTINUE
      IF(SRB .EQ. 0) GO TO 800
      I = 8
      GO TO 50
  800 CONTINUE
      REWIND MT9
      RETURN

C ERROR COMMENT
  900 CONTINUE
      WRITE(IOUT,9902) IER,MT9,AREA
      STOP
   99 CONTINUE
      WRITE (IOUT,9900) NOPT
      STOP
  999 CONTINUE
      WRITE (IOUT,9901) IERROR
      STOP
 9900 FORMAT(//49H ILLEGAL OPTION CONTROL CARD. CARD READ WAS.......,4A6,
     */104H IT SHOULD HAVE BEEN ONE OF THE FOLLOWING.....DEFLECTIONS ONL
     *Y........OR........DEFLECTIONS AND STRESSES)
 9901 FORMAT (//54H TL01 ERROR WHILE TRYING TO EXECUTE THE FOLLOWING CAR
     *D/5(5X,I10))
 9902 FORMAT(//31H FSF ERROR IN MAIN. THE CODE = I5,5X,7HTAPE = I5,5X,
     * 7HAREA = F2.0)
C
 9000 FORMAT(13A6)
 9001 FORMAT(//11H CALCULATE ,4A6)
 9002 FORMAT(//15H STRUCTURE SIZE 7X,5HBEAMS 5X,6HPLATES 4X,
     1 5HNODES 3X,10HPARTITIONS/16X,4I10)
 9100 FORMAT(3I4,4X,I4)
 9101 FORMAT(4A6,3X,I1,2X,I1,2X,I1,2X,I1,2X,I1,2X,I1)
C
      END
```

SUBROUTINE PAGHED

```
$IBFTC PAGH*    DECK
       SUBROUTINE PAGHED
       COMMON /TITL/TITLE(13)
       COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
      * MT13,MT14,MT15,MT16,MT17
       COMMON/PAGE/NPAGE
       IOUT = MT6
       NPAGE=NPAGE+1
       WRITE(IOUT,100)TITLE,NPAGE
   100 FORMAT(1H1,23X,13A6,5X,5HPAGE ,I6)
       RETURN
       END
```

SUBROUTINE UNPACK

```
$IBFTC UNPAC*  DECK
      SUBROUTINE UNPACK(IJKLMN,I,J,K,L,M,N)
C
C     ROUTINE UNPACKS BOUNDARY CONDITIONS
C
      I=IJKLMN/100000
      JP=IJKLMN-100000*I
      J=JP/10000
      KP=JP-10000*J
      K=KP/1000
      LP=KP-1000*K
      L=LP/100
      MP=LP-100*L
      M=MP/10
      N=MP-10*M
C
      RETURN
      END
```

SUBROUTINE PRINT

```
$IBFTC PRINT*  DECK
      SUBROUTINE PRINT (A,NROW,NCOL,CASE,TITLE,PAGE,NIZ)
C
C
C     PRINTS ONE OR TWO DIMENSIONAL ARRAYS
C     LIST OF ARGUMENTS FOR PRINT ROUTINE
C     NROW(I5),NCOL(I5),CASE(I6),TITLE(A6),PAGE(A1)
C
      DIMENSION A(NIZ,1),FMT (4)
      INTEGER FMT,H8
      DATA IOUT/6/,NPRNT/8/,H8/1H8/
      DATA FMT(1)/24H(1X2I3,1P         E14.5)/
C
      IF(NROW.LE.24) WRITE(IOUT,9101)PAGE
      N2=0
      IF(NCOL.LT.NPRNT) GO TO 160
      M=1
   95 FMT(3)=H8
  100 N1=N2+1
      N2=N2+NPRNT
      IF(NROW.GT.24) GO TO 120
      IF(M*(NROW+6     ).LT.60) GO TO 130
  120 M=1
      WRITE(IOUT,9102)
  130 IF(N2.GT.NCOL) GO TO 170
  150 WRITE(IOUT,9103)TITLE,CASE,NROW,NCOL,N1,N2
      WRITE(IOUT,FMT)(I,N1,(A(I,J),J=N1,N2),I=1,NROW)
      M=M+1
      IF(N2.NE.NCOL) GO TO 100
C
      RETURN
C
  160 N1=1
  170 N2=NCOL
      FMT(3)=N2-N1+1
      GO TO 150
C
 9101 FORMAT(A1)
 9102 FORMAT(1H1)
 9103 FORMAT(//1X,7HMATRIX A6,10H IDENT NO.I6,I5,6H ROWS
     1 I5,6H COLS 3X,7H1ST COL,I4,3X,8HLAST COL,I4//)
C
      END
```

SUBROUTINE SUBM1

```
$IBFTC SUBM1*  DECK
      SUBROUTINE SUBM1
C
C     ROUTINE CALLS FOR GENERATION AND MERGER
C     INER=1 IF A QUADRILATERAL PLATE FAILS
C     COPLANARITY TEST (SEE COPLAN SUBROUTINE)
C
      COMMON/CONT1/JPART(800)
      COMMON/CONT2/KPART(800)
      COMMON/CONT3/LPART(800)
      COMMON/RENT/NRENT,KRENT
      COMMON/LASTND/LN(200)
      COMMON/COMS/NSIZE(200)
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP
      COMMON/CONTRL/NDEFL,NKSP,NREX,NNF,NPSTR,NBSTR,NVIB
      COMMON/SKIP/NBSP,NBSB,NBSPI,NBSBI
      COMMON/NOMERG/INER
C
      INER=0
      NRENT=0
      CALL GENRAT
C
      IF(NRENT.NE.0)GO TO 1000
      IF(INER.EQ.1)GO TO 1000
      CALL MERGE
C
 1000 RETURN
      END
```

SUBROUTINE GENRAT

```
$IBFTC GENRA*  DECK
      SUBROUTINE GENRAT
C
C     CONTROL FOR GENERATION OF ELEMENT MATRICES
C
      COMMON/CONT1/JPART(800)
      COMMON/CONT2/KPART(800)
      COMMON/CONT3/LPART(800)
      COMMON/LASTND/LN(200)
      COMMON/CORD/XN(2000),YN(2000),ZN(2000)
      COMMON/CONTRL/NDEFL,NKSP,NREX,NNF,NPSTR,NBSTR,NVIB
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP
      COMMON/ADPRO/EM,G,RC,ALFA,DARC,DL
      COMMON/SSTR/EMM,GG
      COMMON/CHECK/ACPT,GROSS
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/FLAG/NFLAG
      COMMON/TITL/TITLE(13)
C
      IN = MT5
      IOUT = MT6
C
      NFLAG=0
      CALL INFO
C
C
      IF(NPLATE.EQ.0)GO TO 100
      ACPT=0.1
      GROSS=1.0
      READ(IN,9000) EMM,GG
      CALL PAGHED
      CALL PLATE
  100 CONTINUE
C
      IF(NBEAM.EQ.0)GO TO 200
      READ(IN,9000)EMM,GG
      CALL PAGHED
      CALL BEAM
  200 CONTINUE
C
      IF(NFLAG.NE.0)STOP
C
 9000 FORMAT(6E12.4)
      RETURN
      END
```

SUBROUTINE REDUCE

```
$IBFTC REDUC*  DECK
      SUBROUTINE REDUCE(A,N,K)
C
      DIMENSION A(N,N)
C
      DO 100 I=1,N
      DO 100 J=1,N
      IF((I.EQ.K).OR.(J.EQ.K))GO TO 100
      A(I,J)=A(I,J)-A(K,J)*A(I,K)/A(K,K)
  100 CONTINUE
C
      DO 500 L=1,N
      A(L,K)=0.0
  500 A(K,L)=0.0
C
      RETURN
      END
```

SUBROUTINE INFO

```
$IBFTC INFO*    DECK
      SUBROUTINE INFO
C
C     ROUTINE READS IN BOUNDARY CONDITIONS
C     AND WRITES BOUNDARY DATA ON TWO TAPES
C     TAPE IKDF CONTAINS SPECIFIED DEFLECTIONS
C     TAPE IKBC CONTAINS NODAL,B.C. AND SPRING DATA
C     N18 = TAPE CONTAINING REDUCTION INFORMATION
C
      COMMON/CONT1/JPART(800)
      COMMON/CONT2/KPART(800)
      COMMON/CONT3/LPART(800)
      COMMON/LASTND/LN(200)
      COMMON/CORD/XN(2000),YN(2000),ZN(2000)
      COMMON/CONTRL/NDEFL,NKSP,NREX,NNF,NPSTR,NBSTR,NVIB
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NUM1,IUM2,NP
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/TITL/TITLE(13)
      COMMON/REDUC/NTEST
      DIMENSION FKK(6),JKK(6)
      DIMENSION KFIX(6)
      DIMENSIONMAPD(200)
      DIMENSION IRETAN(6)
      EQUIVALENCE(MAPD,JPART)


      IN = MT5
      IOUT = MT6
      IKDF = MT4
      IKBC = MT3
      N18 = MT1
      DO 30 I=1,200
   30 LN(I)=0
C
      DO 40 I=1,800
      JPART(I)=0
      KPART(I)=0
   40 LPART(I)=0
C
```

```
C****** SET UP PARTITIONS
      IF(NP.NE.0)GO TO 100
C
      NP=NNODE/10
      DO 20 I=1,NP
   20 LN(I)=10*I
      IF((NNODE-NP*10).EQ.0)GO TO 99
      NP=NP+1
      LN(NP)=NNODE
   99 CONTINUE
      NUM1=NP
      GO TO 101
  100 NUM1=NP
      READ(IN,9080)(LN(I),I=1,NP)
  101 CONTINUE
C
      WRITE(IOUT,9000)(I,LN(I),I=1,NP)
      CALL PAGHED
      LINE=0
      WRITE(IOUT,9001)
C
C****** LOOP FOR EACH NODE
      DO 500 I=1,NNODE
C
C****** DETERMINE WHICH PARTITION THIS NODE IS IN
      DO 250 K=1,NP
  210 IF(I.GT.LN(K))GO TO 250
      NI=K
      GO TO 251
  250 CONTINUE
  251 CONTINUE

C****** READ IN NODAL DATA
   45 READ(IN,9021) M,JKK,XN(M),YN(M),ZN(M),(IRETAN(IO),IO=1,6)
      DO 47 IO=1,6
   47 IRETAN(IO) = IABS(IRETAN(IO))
      WRITE(N18) M
      WRITE(N18) (IRETAN(IO),IO=1,6)
   46 CONTINUE
      IF(I.NE.M)WRITE(IOUT,9070)M
      DO 51 K=1,6
   51 JKK(K)=IABS(JKK(K))
      IJKLMN=100000*JKK(1)+10000*JKK(2)+1000*JKK(3)+100*JKK(4)+10*JKK(5)
     1+JKK(6)
      WRITE(IKBC)M,IJKLMN
      IF(LINE.LT.50)GO TO 1
      LINE=0
      CALL PAGHED
      WRITE(IOUT,9001)
    1 CONTINUE
      LINE=LINE+1
   60 WRITE(IOUT,9012) M,JKK,XN(M),YN(M),ZN(M),(IRETAN(IO),IO=1,6)
C
   65 K=0
      DO 300 N=1,6
  300 IF(JKK(N).EQ.3)K=1
      IF(K.NE.1)GO TO 350
      READ(IN,9030)(FKK(JJ),JJ=1,6)
      WRITE(IKBC)(FKK(JJ),JJ=1,6)
C****** READ SPRING DATA
```

```
      WRITE(IOUT,9003)(FKK(JJ),JJ=1,6)
      LINE=LINE+1
      IF(LINE.LT.50)GO TO 2
      CALL PAGHED
      LINE=0
      WRITE(IOUT,9001)
    2 CONTINUE
  350 CONTINUE
C
C****** COUNT FIXED DEGREES OF FREEDOM
      K=0
      DO 102 N=1,6
      IF((JKK(N).EQ.0).OR.(JKK(N).EQ.3))GO TO 102
      K=K+1
      KFIX(K)=N
  102 CONTINUE
C
  500 CONTINUE
C
C
 9000 FORMAT(//25H LAST NODES IN PARTITIONS/(1X,10(I3,1H,I4,5X)))
 9001 FORMAT(//41X,10HNODAL DATA//6X,4HNODE,9X,2HBC,14X,1HX,18X,1HY,18X,
     1  1HZ,7X,17HRETAINED FREEDOMS//)
 9002 FORMAT(6X,I4,7X,6I1,6X,1PE12.4,7X,1PE12.4,7X,1PE12.4)
 9003 FORMAT(9H SPRINGS 6E12.4)
 9012 FORMAT(6X,I4,7X,6I1,6X,1PE12.4,7X,1PE12.4,7X,1PE12.4,7X,6I1)
 9020 FORMAT(I4,6X,6I1,8X,3E12.4)
 9021 FORMAT(I4,6X,6I1,8X,3E12.4,4X,6I1)
 9030 FORMAT(6E12.4)
 9040 FORMAT(I4)
 9050 FORMAT(6E12.4)
 9070 FORMAT(6H NODE ,I4,16H OUT OF SEQUENCE )
 9080 FORMAT(18I4)
      REWIND N18
      RETURN
      END
```

SUBROUTINE PLATE

```
$IBFTC PLATE*  DECK
      SUBROUTINE PLATE                                                  431
C                                                                       432
      COMMON/RENT/NRENT,KRENT                                           433
      COMMON/CONT1/JPART(800)                                           434
      COMMON/CONT3/LPART(800)                                           435
      COMMON/LASTND/LN(200)                                             436
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/CORD/XN(2000),YN(2000),ZN(2000)                            440
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,IPT,NPS ,IUM2               441
C                                                                       442
      COMMON/ADPRO/EM,G,RC,ALFA,DARC,DL                                 443
      COMMON/SSTR/EMM,GG                                                444
      COMMON/PSTIF2/H,TS                                                445
      COMMON/PSTIF1/SK(18,18)                                           446
      COMMON/PSTIF8/SKQ(30,30)                                          447
      COMMON/PSTIF9/NP,N5                                               448
      COMMON/PSTIFC/TIBX,TIBY,TIBS                                      449
      COMMON/PSTIFD/TX,TY,TO                                            450
      COMMON/PSTIFG/XS1,YS1,ZS1,XS2,YS2,ZS2,XS3,YS3,ZS3,XS4,YS4,ZS4     451
      COMMON/PMTR1/PT(3,3)
      COMMON/STRAN/GT(8,24)                                             453
      COMMON/FLAG/NFLAG                                                 454
      COMMON/PSTIFL/ISWAP                                               455
      COMMON/SWAP/KSWAP                                                 456
      COMMON/PSTIFH/XL1,YL1,XL2,YL2,XL3,YL3,XL4,YL4                     457
      COMMON/TITL/TITLE(13)
      COMMON/BUCK/IBUC
      COMMON/THRST/TRS1,TRS2,TRS3,TRS4,TRS5,TRS6,TRS7
      COMMON/PSTRSS/SKQSS(30,30)
C                                                                       459
      DIMENSION NN(10),F(24,24),PI(8,40)
      EQUIVALENCE(F,SK)
C                                                                       463
C                                                                       464
C   N4 - NODE NUMBER FOR NODE 4 ON QUADRILATERAL PLATE                  466
C   IO - OUTPUT PARAMETER (1  PRINT)                                    467
C   TIBX - MOMENT OF INERTIA FOR OUT OF PLANE STIFFNESS IN X-DIRECTION  468
C   NP - PLATE NUMBER                                                   465
C   TIBY - MOMENT OF INERTIA FOR OUT OF PLANE STIFFNESS IN Y-DIRECTION  469
C   TX - THICKNESS FOR IN-PLANE LOADING IN X-DIRECTION                  471
C   TIBS - MOMENT OF INERTIA FOR OUT OF PLANE STIFFNESS IN SKIN DIRECTION 470
C   TY - THICKNESS FOR IN-PLANE LOADING IN Y-DIRECTION                  472
C   TO - THICKNESS FOR IN-PLANE SHEAR                                   473
C   TS - THICKNESS FOR SKIN                                             474
C   E - YOUNGS MODULUS                                                  475
C   GAMMA - POISSON,S RATIO                                             476
C   SK66 - STIFFNESS MATRIX FOR (INPST) AND (OUTPM)                     477
C   SK99 - STIFFNESS MATRIX FOR (INP) AND (OUTP)                        478
C XS1,YS1,ZS1 - STRUCTURAL COORDINATE AT NODE 1 TRIANULAR OR QUADRILATER 479
C XS2,YS2,ZS2 - STRUCTURAL COORDINATE AT NODE 2 TRIANULAR OR QUADRILATER 480
C XS3,YS3,ZS3 - STRUCTURAL COORDINATE AT NODE 3 TRIANULAR OR QUADRILATER 481
C XS4,YS4,ZS4 - STRUCTURAL COORDINATE AT NODE 4 QUADRILATERAL PLATE     482
C   XL1,YL1 - LOCAL COORDINATES AT NODE 1 TRIANGULAR OR QUADRILATERAL PLA 483
C   XL2,YL2 - LOCAL COORDINATES AT NODE 2 TRIANGULAR OR QUADRILATERAL PLA 484
C   XL3,YL3 - LOCAL COORDINATES AT NODE 3 TRIANGULAR OR QUADRILATERAL PLA 485
C   XL4,YL4 - LOCAL COORDINATES AT NODE 4 QUADRILATERAL PLATE           486
C                                                                       487
C                                                                       488
C                                                                       489
```

```
C
      ICON(I,J)=1000*MAX0(I,J)+MIN0(I,J)
      IN = MT5
      IOUT = MT6
      KSOLN = MT8
      ISTRS = MT16
      K1=1
      ICC=0
      LINE=0
      WRITE(IOUT,9000)(II,II=1,4)
 1000 NT=0
 1001 NT=NT+1
C     READ PLATE DATA
      READ(IN,9500)NP,N1,N2,N3,N4,IIN,IO,IBUC,T,EM,G
      IF(IBUC.NE.0)READ(IN,9502)TRS1,TRS2,TRS3,TRS4,TRS5,TRS6,TRS7
      IF(EM)1060,1070,1080
 1060 WRITE(IOUT,9560)NP
      EM=ABS(EM)
      GO TO 1080
 1070 EM=EMM
 1080 IF(G)1090,1100,1110
 1090 WRITE(IOUT,9570)NP
      G=ABS(G)
      GO TO 1110
 1100 G=GG
 1110 IF(NP-NT)1120,1125,1120
 1120 WRITE(IOUT,9580)NP,NT
      CALL EXIT
C
 1125 CONTINUE
      KSWAP=0
      IF(IIN-1)1050,2,3
    2 TO=T
      TS=T
      TIBS=T**3/12.
      TX=0.
      TY=0.
      TIBX=0.
      TIBY=0.
      GO TO 1035
    3 READ(IN,9501)TX,TIBX,TY,TIBY,TS,TIBS
      TO=T
      IF(TS.EQ.0.) TS=TO
      IF(TIBS.EQ.0.) TIBS=TO**3/12.
      IF(IIN.EQ.2) GO TO 4
      T=1.-G**2
      TX=-TO*(1.-TX)*T
      TY=-TO*(1.-TY)*T
      TIBX=-TO*(1.-TIBX)*T
      TIBY=-TO*(1.-TIBY)*T
      GO TO 1035
    4 CONTINUE
C     CHECK VALIDITY OF PLATE INPUT
C     POSITIVE MOMENTS OF INERTIA AND THICKNESSES
      IF(NNODE-N1)1020,1005,1005
 1005 IF(NNODE-N2)1020,1010,1010
 1010 IF(NNODE-N3)1020,1015,1015
 1015 IF(NNODE-N4)1020,1025,1025
 1020 WRITE(IOUT,9550)NP
      NFLAG=1
 1025 CONTINUE
```

```
      IF(TIBX.GE.0.)GO TO 1027
      WRITE(IOUT,9590)NP
      TIBX=ABS(TIBX)
 1027 IF(TIBY.GE.0.)GO TO 1029
      WRITE(IOUT,9590)NP
      TIBY=ABS(TIBY)
 1029 IF(TIBS.GE.0.)GO TO 1031
      WRITE(IOUT,9600)NP
      TIBS=ABS(TIBS)
 1031 IF(TX.GE.0.)GO TO 1033
      WRITE(IOUT,9600)NP
      TX=ABS(TX)
 1033 IF(TY.GE.0.)GO TO 1035
      WRITE(IOUT,9600)NP
      TY=ABS(TY)
 1035 IF(TO.GE.0.)GO TO 1037
      WRITE(IOUT,9600)NP
      TO=ABS(TO)
 1037 IF(TS.GE.0.)GO TO 1050
      WRITE(IOUT,9600)NP
      TS=ABS(TS)
 1050 CONTINUE
      WRITE(IOUT,9001)NP,N1,N2,N3,N4,TO,TX,TIBX,TY,TIBY,TS,TIBS,EM,G
      IF(IBUC .NE. 0) WRITE(IOUT,6000) TRS1,TRS2,TRS3
      LINE=LINE+2
      IF(LINE.LT.50)GO TO 10
      CALL PAGHED
      LINE=0
      WRITE(IOUT,9000)(II,II=1,4)
   10 CONTINUE
      M=N1
      XS1=XN(M)
      YS1=YN(M)
      ZS1=ZN(M)
C
      M=N2
      XS2=XN(M)
      YS2=YN(M)
      ZS2=ZN(M)
C
      M=N3
      XS3=XN(M)
      YS3=YN(M)
      ZS3=ZN(M)
C
      N5=N4
      IF(N5.EQ.0)GO TO 1127
      XS4=XN(N5)
      YS4=YN(N5)
      ZS4=ZN(N5)
 1127 CONTINUE
C
C
      DO 1 I=1,30
      DO 1 J=1,30
      SKQSS(I,J)=0.0
    1 SKQ(I,J)=0.0
C
C     CALL THE GENERATION OF THE STIFFNESS AND FIXED END FORCES
      CALL PSTIF(LINE)
  706 CONTINUE
```

```
      IF(LINE.LT.50)GO TO 21
      LINE=0
      CALL PAGHED
      WRITE(IOUT,9000)(II,II=1,4)
   21 CONTINUE
      IF(KRENT.NE.0) GO TO 1002
      IF(ISWAP.EQ.0) GO TO 1251
      NSAVE=N3
      N3=N4
      N4=NSAVE
      KSWAP=1
      GO TO 10
 1251 CONTINUE
C
 1002 CONTINUE
C     CONNECTIVITY INFO FOR PLATE
C
C
      MPT=IPT-1
      DO 1129 I=1,MPT
      IF((N1.LE.LN(I+1)).AND.(N1.GT.LN(I)))NI=I+1
      IF((N2.LE.LN(I+1)).AND.(N2.GT.LN(I)))NJ=I+1
      IF((N3.LE.LN(I+1)).AND.(N3.GT.LN(I)))NK=I+1
      IF((N4.LE.LN(I+1)).AND.(N4.GT.LN(I)))NL=I+1
      IF(N1.LE.LN(1))NI=1
      IF(N2.LE.LN(1))NJ=1
      IF(N3.LE.LN(1))NK=1
      IF(N4.LE.LN(1))NL=1
 1129 CONTINUE
      LL=6
      NN(1)=1001*NI
      NN(2)=ICON(NJ,NI)
      NN(3)=1001*NJ
      NN(4)=ICON(NK,NI)
      NN(5)=ICON(NK,NJ)
      NN(6)=1001*NK
      IF(N4.EQ.0)GO TO 1132
      NN(7)=ICON(NL,NI)
      NN(8)=ICON(NL,NJ)
      NN(9)=ICON(NL,NK)
      NN(10)=1001*NL
      LL=10
 1132 CONTINUE
      DO 1135 J=1,LL
      DO 1134 I=1,K1
      II=I
      IF(JPART(I).EQ.NN(J))GO TO 1135
 1134 CONTINUE
      II=K1
      K1=K1+1
      JPART(II)=NN(J)
      LPART(II)=10001*NP
 1135 LPART(II)=(LPART(II)/10000)*10000+NP
      NPS=K1-1
C
C     CALL FOR 6X6 TRANSFORMATION
      CALL PMTR
C
C     CALL FOR STRESS TRANSFORMATION
      CALL SMTR
C
```

```
C
      LIM=18
      IF(N4.NE.0)LIM=24
C     * * *          TRANSFORMATION- K(LAMBDA-T) * * *
C
      CALL KLAMT(SKQSS,PT)
C
C     * * * GENERATE STRESS MATRIX * * *
C
      DO 1275 I=1,8
      DO 1275 J=1,24
 1275 PI(I,J)=0.0
C
      CALL MUL1(GT,SKQSS,PI,1,8,LIM,LIM,8,30,8)
      IF(IBUC)1276,1277,1276
 1276 CALL KLAMT(SKQ,PT)
      GO TO 1279
 1277 DO 1278 I=1,30
      DO 1278 J=1,30
 1278 SKQ(I,J)=SKQSS(I,J)
C     * * *  COMPLETE COORD. TRANSFORMATION - LAMBDA(K*LAMDA-T) * * *
 1279 CALL LAMK(SKQ,PT)
C     WRITING STIFFNESS
C
      WRITE(KSOLN)N1,N2,N3,N4
C
      WRITE(KSOLN)((SKQ (J,I),J=1,6),I=1,6),
     1((SKQ(J,I),J= 1, 6),I= 7,12),((SKQ(J,I),J= 1, 6),I=13,18),
     2((SKQ(J,I),J= 1, 6),I=19,24),((SKQ(J,I),J= 7,12),I= 1, 6),
     3((SKQ(J,I),J= 7,12),I= 7,12),((SKQ(J,I),J= 7,12),I=13,18),
     4((SKQ(J,I),J= 7,12),I=19,24),((SKQ(J,I),J=13,18),I= 1, 6),
     5((SKQ(J,I),J=13,18),I= 7,12),((SKQ(J,I),J=13,18),I=13,18),
     6((SKQ(J,I),J=13,18),I=19,24),((SKQ(J,I),J=19,24),I= 1, 6),
     7((SKQ(J,I),J=19,24),I= 7,12),((SKQ(J,I),J=19,24),I=13,18),
     8((SKQ(J,I),J=19,24),I=19,24)
C     WRITING STRESS
C
      WRITE(ISTRS)NP,N1,N2,N3,N4
      WRITE(ISTRS)((PI(I,J),I=1,8),J=1,24)
C
C
      IF(IO.NE.1)GO TO 1280
C     PRINT OPTIONS FOR INDIVIDUAL PLATE
      CALL PRINT(GT,8,LIM,1,4HSMTR,1,8)
      CALL PRINT(SKQ,LIM,LIM,1,4HSTIF,1,30 )
      CALL PRINT(PI,8,LIM,1,4HSTRS,1,8)
 1280 CONTINUE
C
C
C
C
C
C
      IF(NPLATE-NT)2003,2003,1001
C
C
 2003 CONTINUE
C
 6000 FORMAT(15X,10HSIGMA-X = ,E12.5,3X,10HSIGMA-Y = ,E12.5,3X,9HTAU-XY
     *= ,E12.5)
 9000 FORMAT(/56X,10HPLATE DATA//
     1 1X,    6H PLATE,4(5H NODE ),4X,4HT(O),7X,4HT(X),7X,4HI(X),7X,
     2 4HT(Y),7X,4HI(Y),7X,4HT(S),7X,4HI(S),9X,1HE,7X,5HGAMMA//5X,4I5//)
 9001 FORMAT(1X,5I5,9(1PE11.3))
 9500 FORMAT(7I4,4X,I2,2X,3E12.4)
 9501 FORMAT(6E12.4)
 9502 FORMAT (7E10.4)
 9550 FORMAT(34H1INCORRECT NODE NUMBER, PLATE NO. I4)
 9560 FORMAT(43H1NEGATIVE MODULUS OF ELASTICITY, PLATE NO. I4)
 9570 FORMAT(35H1NEGATIVE POISSON RATIO, PLATE NO. I4)
 9580 FORMAT(41H1INPUT NOT IN PROPER SEQUENCE, PLATE NO. I4,
     111H SHOULD BE I4)
 9590 FORMAT(38H1NEGATIVE MOMENT OF INTERTIA,PLATE NO. I4)
 9600 FORMAT(31H1NEGATIVE THICKNESS, PLATE NO. I4)
C
      RETURN
      END
```

SUBROUTINE MUL1

```
$IBFTC MUL1*    DECK
      SUBROUTINE MUL1(A,B,C,NT,N1,N2,N3,ID1,ID2,ID3)
C
C     NT=1    C=A*B
C     LIMITS OF MULTIPLY  A(N1,N2)  B(N2,N3)  C(N1,N3)
C
      DIMENSION A(ID1,1),B(ID2,1),C(ID3,1)
C
      DO 100 I=1,N1
      DO 100 J=1,N3
      C(I,J)=0.0
      DO 100 K=1,N2
  100 C(I,J)=C(I,J)+A(I,K)*B(K,J)
  400 RETURN
      END
```

SUBROUTINE MUL2

```
$IBFTC MUL2*    DECK
      SUBROUTINE MUL2(A,B,C,NT,N1,N2,N3,ID1,ID2,ID3)
C
C     NT=2    C=A(TRANSPOSE)*B
C     LIMITS OF MULTIPLY  A(N1,N2)  B(N2,N3)  C(N1,N3)
C
      DIMENSION A(ID1,1),B(ID2,1),C(ID3,1)
C
      DO 300 I=1,N1
      DO 300 J=1,N3
      C(I,J)=0.0
      DO 300 K=1,N2
  300 C(I,J)=C(I,J)+A(K,I)*B(K,J)
C
  400 RETURN
      END
```

SUBROUTINE PSTIF

```
$IBFTC PSTIF*  DECK
      SUBROUTINE PSTIF(LINE)
      COMMON/RENT/NRENT,KRENT                                            865
      COMMON/TPLN1/NERR                                                  882
      COMMON/PSTIFL/ISWAP                                                886
      COMMON/PSTIF9/NP,N4
C                                                                        888
C                                                                        890
C FORM LOCAL COORDINATES FROM STRUCTURAL COORDINATES                     891
C FOR TRIANGULAR OR QUADRILATERAL PLATE                                  892
C                                                                        893
      CALL LOCAL                                                         894
      IF(KRENT.NE.0)GO TO 2                                              895
      IF(ISWAP.NE.0)GO TO 150                                            896
    2 CONTINUE                                                           897
C                                                                        905
C FOR ANALYSIS OF TRIANGULAR PLATE, N4=0                                 906
C                                                                        907
      IF(N4.NE.0)GO TO 130                                               908
   10 CALL TRI                                                           909
      GO TO 150                                                          946
C                                                                        947
C FOR ANALYSIS OF QUADRILATERAL PLATE, N4 DOES NOT EQUAL 0               948
C                                                                        949
C CHECK COPLANARITY OF QUADRILATERAL PLATE                               950
C                                                                        951
  130 CALL COPLAN(NERR)                                                  952
      CALL QUAD(LINE)
  150 RETURN                                                             954
      END                                                                957
```

SUBROUTINE QUAD

```
$IBFTC QUAD*    DECK
      SUBROUTINE QUAD(LINE)
C                                                                        961
C GENERATE STIFFNESS AND TEMPERATURE LOADS FOR QUADRILATERAL PLATE       962
C                                                                        963
      COMMON/PSTIF2/H,TS                                                 964
      COMMON/ADPRO/E,GAMMA,DUM1,DUM2,DUM3,DUM4                           965
      COMMON/PSTIF3/X1,Y1,X2,Y2,X3,Y3                                    966
      COMMON/PSTIF5/TLOAD(18),DEFL(18)                                   967
      COMMON/PSTIF8/SKQ(30,30)                                           968
      COMMON/PSTIFH/XL1,YL1,XL2,YL2,XL3,YL3,XL4,YL4                      969
      COMMON/PSTIFK/NQUA                                                 970
      COMMON/PSTIFL/ISWAP                                                971
      COMMON/TEMP2/A(9,40)                                               972
      COMMON/TPLN1/NERR                                                  973
      COMMON/RENT/NRENT                                                  977
      COMMON/SWAP/KSWAP                                                  978
      COMMON/LOAD/LDPT                                                   979
      COMMON/PSTRSS/SKQSS(30,30)
      COMMON/BUCK/IBUC
      EQUIVALENCE(XYL(1),XL1),(XY(1),X2)                                 980
      DIMENSION XYL(8),XY(4)                                             982
C                                                                        983
C FIND FIFTH NODE                                                        984
C                                                                        985
      XL23=XL2-XL3                                                       986
      P34=XL4*YL3+YL4*XL23                                               987
      X1=(XL4+XL3+(XL2*YL4*XL23/P34))/3.0                                988
      Y1=(YL4+YL3-(XL2*YL4*YL3/P34))/3.0                                 989
C                                                                        990
C ZERO THE ELEMENTS OF SKQ(30,30)                                        991
C                                                                        992
      DO 10 J=1,30                                                       993
      DO 10 I=1,30                                                       994
   10 SKQ(I,J)=0.0                                                       995
C                                                                        996
C SUBDIVIDED TRIANGULAR PLATES OF THE QUADRILATERAL PLATE               1038
C                                                                       1039
   19 DO 240 NQUA=1,4                                                   1040
      DO 90 I=1,4                                                       1041
      GO TO(50,20,30,40),NQUA                                           1042
   20 GO TO(60,60,70,70),I                                              1043
   30 GO TO(80,80,60,60),I                                              1044
   40 GO TO(70,70,81,81),I                                              1045
   50 I1=I                                                              1046
      GO TO 85                                                          1047
   60 I1=I+2                                                            1048
      GO TO 85                                                          1049
   70 I1=I+4                                                            1050
      GO TO 85                                                          1051
   80 I1=I+6                                                            1052
      GO TO 85                                                          1053
   81 I1=I-2                                                            1054
   85 XY(I)=XYL(I1)                                                     1055
   90 CONTINUE                                                          1056
      CALL TRI                                                          1057
  240 CONTINUE                                                          1133
C                                                                       1134
C REDUCE OUT FIFTH NODE FROM STIFFNESS MATRIX SKQ(30,30)                1135
C                                                                       1137
      DO 246 K=25,30
  246 CALL REDUCE(SKQSS,30,K)
      IF(IBUC.EQ.0)GO TO 280
      DO 245 K=25,30
  245 CALL REDUCE(SKQ,30,K)
C
  280 RETURN
      END
```

SUBROUTINE LAMK

```
$IBFTC LAMK*    DECK
      SUBROUTINE LAMK(SK,PT)
      DIMENSION SK(3,300),PT(3,3),P(3)
      DO 50 I=1,300
      DO 25 IR=1,3
      P(IR)=0.
      DO 25 IC=1,3
      P(IR)=P(IR)+PT(IR,IC)*SK(IC,I)
   25 CONTINUE
      DO 50 IC=1,3
      SK(IC,I)=P(IC)
   50 CONTINUE
      RETURN
      END
```

SUBROUTINE KLAMT

```
$IBFTC KLAMT*  DECK
      SUBROUTINE KLAMT(SK,PT)
      DIMENSION SK(30,3,10),PT(3,3),P(3)
      DO 50 I=1,10
      DO 50 J=1,30
      DO 25 IR=1,3
      P(IR)=0.0
      DO 25 IC=1,3
      P(IR)=P(IR)+PT(IR,IC)*SK(J,IC,I)
   25 CONTINUE
      DO 50 IC=1,3
      SK(J,IC,I)=P(IC)
   50 CONTINUE
      RETURN
      END
```

SUBROUTINE TRI

```
$IBFTC TRI*    DECK
      SUBROUTINE TRI
C
C TRIANGULAR PLATE STIFFNESS GENERATION SK(18,18)
C
C
      COMMON/PSTIF1/SK(18,18)
      COMMON/PSTIF3/X1,Y1,X2,Y2,X3,Y3
      COMMON/PSTIF7/X21,X31,X32,Y21,Y31,Y32
      COMMON/PSTIF9/NP,N4
      COMMON/PSTIFH/XL1,YL1,XL2,YL2,XL3,YL3,XL4,YL4
      COMMON/PSTIFD/TX,TY,TO
      COMMON/BUCK/IBUC
      COMMON/THRST/TRS1,TRS2,TRS3,TRS4,TRS5,TRS6,TRS7
      COMMON/PREST/SKPRE(6)
C
C
C ************* DEFINITION OF ARGUMENTS *************
C
C X1,Y1 - LOCAL COORDINATES AT NODE 1 OF TRIANGULAR PLATE
C X2,Y2 - LOCAL COORDINATES AT NODE 2 OF TRIANGULAR PLATE
C X3,Y3 - LOCAL COORDINATES AT NODE 3 OF TRIANGULAR PLATE
C
C
C
      EQUIVALENCE(XLOCAL,XL1)
      DIMENSION XLOCAL(8)
      T = TO
C
      IF(N4.NE.0)GO TO 5
    1 X1=XL1
      Y1=YL1
      X2=XL2
      Y2=YL2
      X3=XL3
      Y3=YL3
C
C THE FOLLOWING PROJECTIONS, (LENGTHS), ARE USED IN ROUTINES
C INPST,OUTSH,INPM AND PTEMP
C
    5 X21 = X2-X1
      X31 = X3-X1
      X32 = X3-X2
      Y21 = Y2-Y1
      Y31 = Y3-Y1
      Y32 = Y3-Y2
C
C THE FOLLOWING ZERO'S THE SK ARRAY
C
      DO 10 J=1,18
      DO 10 I=1,18
   10 SK(I,J)=0.0


C GENERATE K1 FOR TRIANGULAR ELEMENT

      IF(IBUC.EQ.0)GO TO 20
      IF(N4.EQ.0) GO TO 40
      XT2=SQRT(X21**2 + Y21**2)
      XT3=(X21*X31 + Y21*Y31)/XT2
      YT3=SQRT(X31**2 + Y31**2 - XT3**2)
      XT32 = XT3 - XT2
      CES = X21/XT2
      SEN = Y21/XT2
      T4A=T/(2.*XT2*YT3)
      TS1T=T4A*TRS1
      TS2T=T4A*TRS2
      TS3T=T4A*TRS3
      TS1=((CES**2)*TS1T + (SEN**2)*TS2T + 2.*(SEN*CES)*TS3T)
      TS2=((SEN**2)*TS1T + (CES**2)*TS2T - 2.*(SEN*CES)*TS3T)
      TS3=((SEN*CES)*(TS2T-TS1T) + (CES**2-SEN**2)*TS3T)
      GO TO 19
   40 XT2=X2
      XT3=X3
      YT3=Y3
      XT32=X32
      T4A=T/(2.*XT2*YT3)
      TS1=T4A*TRS1
      TS2=T4A*TRS2
      TS3=T4A*TRS3
   19 SKPRE(1)=TS1*YT3*YT3+TS2*XT32*XT32-TS3*2.*XT32*YT3
      SKPRE(2)=-TS1*YT3*YT3-TS2*XT32*XT3+TS3*YT3*(XT3+XT32)
      SKPRE(3) =TS1*YT3*YT3+TS2*XT3*XT3-TS3*2.*XT3*YT3
      SKPRE(4) =TS2*XT32*XT2-TS3*XT2*YT3
      SKPRE(5) =-TS2*XT3*XT2+TS3*XT2*YT3
      SKPRE(6) =TS2*XT2*XT2
   20 CONTINUE
C
C GENERATE STIFFNESS FOR IN-PLANE EFFECTS (INP)
C
      CALL INP
      CALL STORE(2)
C
C
C
C GENERATE STIFFNESS FOR OUT OF PLANE EFFECTS (OUTP)
C
      CALL OUTP
      CALL STORE(0)
C
  100 RETURN
      END
```

SUBROUTINE INP

```
$IBFTC INP*    DECK
      SUBROUTINE INP
      COMMON/PSTIFA/SK66(6,6)/PSTIFB/SK99(9,9)
C
C *****************************************************************
C GENERATE STIFFNESS FOR IN-PLANE EFFECTS (INP) FOR TRIANGULAR PLATE
C *****************************************************************
C
C
C GENERATE STIFFNESS FOR IN-PLANE STRETCHING (INPS)
C
      CALL INPST(1)
C
C GENERATE STIFFNESS FOR IN-PLANE MOMENTS (INPM)
C
      CALL INPM
C
C COMBINE (INPST) AND (INPM) STIFFNESS INTO (INP) STIFFNESS
C
      CALL COMBIN(1)
      RETURN
      END
```

SUBROUTINE INPM

```
$IBFTC INPM*   DECK
      SUBROUTINE INPM
C
C GENERATE THE STIFFNESS CONTRIBUTION DUE TO
C IN-PLANE MOMENTS IN THE ELEMENTS OF UPPER TRIANGLE OF SK99
C
      COMMON/PSTIF2/H,TS
      COMMON/ADPRO/E,GAMMA,DUM1,DUM2,DUM3,DUM4
      COMMON/PSTIF7/X21,X31,X32,Y21,Y31,Y32
      COMMON/PSTIF9/NP,N4
      COMMON/PSTIFB/SK99(9,9)
      COMMON/PSTIFD/TX,TY,TO
C
      DIMENSION XY(3,2),D(3),SC(3,2),SC2(3,2),E2AI(3),
     * AD(3),ID(3),ID2(3),ID3(3),ID2SC(3,2),ID3SC2(3,2),ADSC2(3,2),AI(3)
C
      EQUIVALENCE (X21,XY(1,1))
      REAL ID,ID2,ID3,ID2SC,ID3SC2
      TXY(A)=0.5*((TX+TO)*(1.0+(A))+(TX+TO)*(1.0-(A)))*A2
C
      A2=(X21*Y31-Y21*X31)/6.0
      TO1=(TO/12.0)*A2**3
C
      E2=E
      E4=2.*E
      E8=4.*E
      E12=6.*E
      E24=12.*E
C
C
C D(1) IS D12, ETC.
C
      DO 10 I=1,3
   10 D(I)=SQRT(XY(I,1)**2+XY(I,2)**2)
C
C SC(1,1) IS SIN12,SC(1,2) IS COS12, ETC.
C
      DO 20 J=1,2
      DO 20 I=1,3
   20 SC(I,J)=XY(I,J)/D(I)
      SC(2,1)=-SC(2,1)
      SC(2,2)=-SC(2,2)
C
C SC2(1,1) IS SIN12**2, ETC.
C
      DO 30 J=1,2
      DO 30 I=1,3
   30 SC2(I,J)=SC(I,J)**2
C
C AD(1) IS A12/D12, ETC.
C
      DO 50 I=1,3
   50 AD(I)=0.
C
C ID(1) IS I12/D12, ETC.
C
      DO 60 I=1,3
   60 ID(I)=T01/(D(I)**4)
C
C ID2(1) IS I12/(D12**2), ETC.
C
      DO 70 I=1,3
   70 ID2(I)=ID(I)/D(I)
C
C ID3(1) IS I12/(D12**2), ETC.
C
      DO 80 I=1,3
   80 ID3(I)=ID2(I)/D(I)
C
C ID2SC(1,1) IS I12*SIN12/(D12**2), ETC.
C
      DO 90 J=1,2
      DO 90 I=1,3
   90 ID2SC(I,J)=ID2(I)*SC(I,J)
C
C ID3SC2(1,1) IS I12*SIN12**2/(D12**3), ETC.
C
      DO 100 J=1,2
      DO 100 I=1,3
  100 ID3SC2(I,J)=ID3(I)*SC2(I,J)
C
C ADSC2(1,1) IS A12*SIN12**2/D12, ETC.
C
      DO 110 J=1,2
      DO 110 I=1,3
  110 ADSC2(I,J)=AD(I)*SC2(I,J)
C
C E2AI(1) IS 2*E*(SIN12*COS12*(A12/D12-I12/(D12**3))), ETC.
C
      DO 120 I=1,3
  120 E2AI(I)=SC(I,1)*SC(I,2)*(AD(I)-12.0*ID3(I))*E2
C
C ROW1
C
      SK99(1,1) =   E8*(ID(1) + ID(2))
      SK99(1,2) = - E12*(ID2SC(1,2) - ID2SC(2,2))
      SK99(1,3) =   E12*(ID2SC(1,1) - ID2SC(2,1))
      SK99(1,4) =   E4*ID(1)
      SK99(1,5) =   E12*ID2SC(1,2)
      SK99(1,6) = - E12*ID2SC(1,1)
      SK99(1,7) =   E4*ID(2)
      SK99(1,8) = - E12*ID2SC(2,2)
      SK99(1,9) =   E12*ID2SC(2,1)
C
C ROW2
C
      SK99(2,2) =   E2*(ADSC2(1,1) + ADSC2(2,1)) +
     *              E24*(ID3SC2(1,2) + ID3SC2(2,2))
      SK99(2,3) =   E2AI(1) + E2AI(2)
      SK99(2,4) = - SK99(1,5)
      SK99(2,5) = - E2*(ADSC2(1,1) + 12.0*ID3SC2(1,2))
      SK99(2,6) = - E2AI(1)
      SK99(2,7) = - SK99(1,8)
      SK99(2,8) = - E2*(ADSC2(2,1) + 12.0*ID3SC2(2,2))
      SK99(2,9) = - E2AI(2)
C
C ROW3
```

```
C
      SK99(3,3) =   E2*(ADSC2(1,2) + ADSC2(2,2)) +
     *              E24*(ID3SC2(1,1) + ID3SC2(2,1))
      SK99(3,4) = - SK99(1,6)
      SK99(3,5) = - E2AI(1)
      SK99(3,6) = - E2*(ADSC2(1,2) + 12.0*ID3SC2(1,1))
      SK99(3,7) = - SK99(1,9)
      SK99(3,8) = - E2AI(2)
      SK99(3,9) = - E2*(ADSC2(2,2) + 12.0*ID3SC2(2,1))
C
C ROW4
C
      SK99(4,4) =   E8*(ID(1) + ID(3))
      SK99(4,5) = - E12*(ID2SC(3,2) - ID2SC(1,2))
      SK99(4,6) =   E12*(ID2SC(3,1) - ID2SC(1,1))
      SK99(4,7) =   E4*ID(3)
      SK99(4,8) =   E12*ID2SC(3,2)
      SK99(4,9) = - E12*ID2SC(3,1)
C
C ROW5
C
      SK99(5,5) =   E2*(ADSC2(1,1) + ADSC2(3,1)) +
     *              E24*(ID3SC2(1,2) + ID3SC2(3,2))
      SK99(5,6) =   E2AI(1) + E2AI(3)
      SK99(5,7) = - SK99(4,8)
      SK99(5,8) = - E2*(ADSC2(3,1) + 12.0*ID3SC2(3,2))
      SK99(5,9) = - E2AI(3)
C
C ROW6
C
      SK99(6,6) =   E2*(ADSC2(1,2) + ADSC2(3,2)) +
     *              E24*(ID3SC2(1,1) + ID3SC2(3,1))
      SK99(6,7) = - SK99(4,9)
      SK99(6,8) = - E2AI(3)
      SK99(6,9) = - E2*(ADSC2(3,2) + 12.0*ID3SC2(3,1))
C
C ROW7
C
      SK99(7,7) =   E8*(ID(2) + ID(3))
      SK99(7,8) = - E12*(ID2SC(2,2) - ID2SC(3,2))
      SK99(7,9) =  -E12*(ID2SC(3,1) - ID2SC(2,1))
C
C ROW8
C
      SK99(8,8) =   E2*(ADSC2(3,1) + ADSC2(2,1)) +
     *              E24*(ID3SC2(3,2) + ID3SC2(2,2))
      SK99(8,9) =   E2AI(2) + E2AI(3)
C
C ROW9
C
      SK99(9,9) = + E2*(ADSC2(2,2) + ADSC2(3,2)) +
     *              E24*(ID3SC2(2,1) + ID3SC2(3,1))
C
  200 RETURN
      END
```

SUBROUTINE INPST

```
$IBFTC INPST*  DECK
      SUBROUTINE INPST(N)
C
C GENERATE STIFFNESS FOR IN-PLANE STRETCHING IN UPPER TRIANGLE
C OF SK66(I,J) ELEMENTS.
C
C  N=1, GENERATE (INPST)
C  N=0, GENERATE (OUTPM)
C
      COMMON/PSTIF2/H,TS
      COMMON/ADPRO/E,GAMMA,DUM1,DUM2,DUM3,DUM4
      COMMON/PSTIF7/X21,X31,X32,Y21,Y31,Y32
      COMMON/PSTIF9/NP,N4
      COMMON/PSTIFA/SK66(6,6)
      COMMON/PSTIFC/TIBX,TIBY,TIBS
      COMMON/PSTIFD/TX,TY,TO
C
      PHI = E/(ABS(X21*Y31-Y21*X31)*(1.0-GAMMA**2)*2.0)
      IF(N.EQ.0) GO TO 10
      T1 = (0.5*TO*(1.0-GAMMA))*PHI
      T2 = (0.5*TO*(1.0+GAMMA))*PHI
      GAT = GAMMA*TO*PHI
      TPX = (TO+TX*(1.0-GAMMA**2))*PHI
      TPY = (TO+TY*(1.0-GAMMA**2))*PHI
      GO TO 20
   10 TOX=TIBS
      T1 = (0.5*TOX*(1.0-GAMMA))*PHI
      T2 = (0.5*TOX*(1.0+GAMMA))*PHI
      GAT = GAMMA*TOX*PHI
      TPX = (TOX+TIBX*(1.0-GAMMA**2))*PHI
      TPY = (TOX+TIBY*(1.0-GAMMA**2))*PHI
C
C ROW 1
C
   20 SK66(1,1) =    TPX*Y32**2  + T1*X32**2
      SK66(1,2) =                - T2*X32*Y32
      SK66(1,3) = - TPX*Y31*Y32 - T1*X31*X32
      SK66(1,4) =   GAT*X31*Y32 + T1*Y31*X32
      SK66(1,5) =   TPX*Y21*Y32 + T1*X21*X32
      SK66(1,6) = - GAT*X21*Y32 - T1*Y21*X32
C
C ROW 2
C
      SK66(2,2) =   TPY*X32**2  + T1*Y32**2
      SK66(2,3) =   GAT*Y31*X32 + T1*X31*Y32
      SK66(2,4) = - TPY*X31*X32 - T1*Y31*Y32
      SK66(2,5) = - GAT*Y21*X32 - T1*X21*Y32
      SK66(2,6) =   TPY*X21*X32 + T1*Y21*Y32
C
C ROW 3
C
      SK66(3,3) =   TPX*Y31**2  + T1*X31**2
      SK66(3,4) =               - T2*X31*Y31
      SK66(3,5) = - TPX*Y21*Y31 - T1*X21*X31
      SK66(3,6) =   GAT*X21*Y31 + T1*Y21*X31
C
C ROW 4
```

```
C
      SK66(4,4) =   TPY*X31**2  + T1*Y31**2
      SK66(4,5) =   GAT*X31*Y21 + T1*X21*Y31
      SK66(4,6) = - TPY*X21*X31 - T1*Y21*Y31
C
C ROW 5
C
      SK66(5,5) =   TPX*Y21**2  + T1*X21**2
      SK66(5,6) =                -T2*X21*Y21
C
C ROW 6
C
      SK66(6,6) =   TPY*X21**2  + T1*Y21**2
C
  200 RETURN
      END
```

SUBROUTINE OUTP

```
$IBFTC OUTP*   DECK
      SUBROUTINE OUTP
      COMMON/PSTIFA/SK66(6,6)/PSTIFB/SK99(9,9)
C
C *******************************************************************
C GENERATE STIFFNESS FOR OUT OF PLANE EFFECTS (OUTP) FOR TRIANGULAR PLAT
C *******************************************************************
C
C
C GENERATE STIFFNESS FOR OUT OF PLANE MOMENTS (OUTPM)
C
      CALL OUTPM
C
C GENERATE STIFFNESS FOR OUT OF PLANE SHEAR (OUTPSH)
C
      CALL OUTPSH
C
C COMBINE (OUTPM) AND (OUTPSH) STIFFNESS INTO (OUTP) STIFFNESS
C
      CALL COMBIN (0)
      RETURN
      END
```

SUBROUTINE OUTPM

```
$IBFTC OUTPM*  DECK
      SUBROUTINE OUTPM
C
C GENERATE STIFFNESS FOR OUT OF PLANE MOMENTS BY TRANSFORMATION
C OF IN-PLANE STRETCHING STIFFNESS MATRIX, (SEE SUBROUTINE (INPST)),
C OTHER CHANGES AS INDICATED BELOW
C
      COMMON/PSTIFA/SK66(6,6)
      COMMON/PSTIFC/TIBX,TIBY,TIBS
      COMMON/PSTIFD/TX,TY,TO
C
C
      CALL INPST(0)
      I=1
   10 SAVE=SK66(I,I)
      SK66(I,I)=SK66(I+1,I+1)
      SK66(I+1,I+1)=SAVE
      SK66(I,I+1)=-SK66(I,I+1)
      I=I+2
      IF(I.LE.5) GO TO 10
      J=3
   20 I=1
   30 SAVE=SK66(I,J)
      SK66(I,J)=SK66(I+1,J+1)
      SK66(I+1,J+1)=SAVE
      SAVE=-SK66(I+1,J)
      SK66(I+1,J)=-SK66(I,J+1)
      SK66(I,J+1)=SAVE
      I=I+2
      IF(I.LT.J)GO TO 30
      J=J+2
      IF(J.LE.5)GO TO 20
      RETURN
      END
```

SUBROUTINE OUTPSH

```
$IBFTC OUTPS*  DECK
      SUBROUTINE OUTPSH
C
C GENERATE THE STIFFNESS CONTRIBUTION DUE TO OUT OF PLANE
C SHEAR (OUTPSH) IN THE ELEMENTS OF SKQ(I,J,22),SKQ(I,J,23),
C
      COMMON/PSTIF2/H,TS
      COMMON/ADPRO/E,GAMMA,DUM1,DUM2,DUM3,DUM4
      COMMON/PSTIF7/X21,X31,X32,Y21,Y31,Y32
      COMMON/PSTIFB/SK99(9,9)
C
C
      G = E/(2.0*(1.0 + GAMMA))
      ALP = (G*TS)/(8.0*ABS(Y21*X31-Y31*X21))
      ALP12 = ALP*ABS(Y31*Y32+X31*X32)
      ALP13 = ALP*ABS(Y21*Y32+X21*X32)
      ALP23 = ALP*ABS(Y21*Y31+X21*X31)
C
C ROW1
C
      SK99(1,1) =   ALP12*Y21**2 + ALP13*Y31**2
      SK99(1,2) = - (ALP12*X21*Y21 + ALP13*X31*Y31)
      SK99(1,3) =   2.0*(ALP12*Y21 + ALP13*Y31)
      SK99(1,4) =   ALP12*Y21**2
      SK99(1,5) = - ALP12*X21*Y21
      SK99(1,6) = - 2.0*ALP12*Y21
      SK99(1,7) =   ALP13*Y31**2
      SK99(1,8) = - ALP13*X31*Y31
      SK99(1,9) = - 2.0*ALP13*Y31
C
C ROW2
C
      SK99(2,2) =   ALP12*X21**2 + ALP13*X31**2
      SK99(2,3) = - 2.0*(ALP12*X21 + ALP13*X31)
      SK99(2,4) = - ALP12*X21*Y21
      SK99(2,5) =   ALP12*X21**2
      SK99(2,6) =   2.0*ALP12*X21
      SK99(2,7) = - ALP13*X31*Y31
      SK99(2,8) =   ALP13*X31**2
      SK99(2,9) =   2.0*ALP13*X31
C
C ROW3
C
      SK99(3,3) =   4.0*(ALP12+ALP13)
      SK99(3,4) =   2.0*ALP12*Y21
      SK99(3,5) = - 2.0*ALP12*X21
      SK99(3,6) = - 4.0*ALP12
      SK99(3,7) =   2.0*ALP13*Y31
      SK99(3,8) = - 2.0*ALP13*X31
      SK99(3,9) = - 4.0*ALP13
C
C ROW4
C
      SK99(4,4) =   ALP12*Y21**2 + ALP23*Y32**2
      SK99(4,5) = - (ALP12*X21*Y21 + ALP23*X32*Y32)
      SK99(4,6) = - 2.0*(ALP12*Y21-ALP23*Y32)
      SK99(4,7) =   ALP23*Y32**2
      SK99(4,8) = - ALP23*X32*Y32
      SK99(4,9) = - 2.0*ALP23*Y32
C
C ROW5
C
      SK99(5,5) =   ALP12*X21**2+ALP23*X32**2
      SK99(5,6) =   2.0*(ALP12*X21-ALP23*X32)
      SK99(5,7) = - ALP23*X32*Y32
      SK99(5,8) =   ALP23*X32**2
      SK99(5,9) =   2.0*ALP23*X32
C
C ROW6
C
      SK99(6,6) =   4.0*(ALP12 + ALP23)
      SK99(6,7) =   2.0*ALP23*Y32
      SK99(6,8) = - 2.0*ALP23*X32
      SK99(6,9) = - 4.0*ALP23
C
C ROW7
C
      SK99(7,7) =  ALP13*Y31**2+ALP23*Y32**2
      SK99(7,8) = -(ALP13*X31*Y31 + ALP23*X32*Y32)
      SK99(7,9) = -2.0*(ALP13*Y31 + ALP23*Y32)
C
C ROW8
C
      SK99(8,8) =   ALP13*X31**2 + ALP23*X32**2
      SK99(8,9) =   2.0*(ALP13*X31 + ALP23*X32)
C
C ROW9
C
      SK99(9,9) =  4.0*(ALP13 + ALP23)
C
      RETURN
      END
```

SUBROUTINE COMBIN

```
$IBFTC COMBI*  DECK
      SUBROUTINE COMBIN(N)
C
C  N=1, WILL COMBINE IN-PLANE STRETCHING STIFFNESS (INPST) AND
C       IN-PLANE MOMENT STIFFNESS (INPM) IN UPPER TRIANGLE OF SK99
C  N=0, WILL COMBINE OUT OF PLANE MOMENT STIFFNESS (OUTPM) AND
C       OUT OF PLANE SHEAR STIFFNESS
C
      COMMON/PSTIFA/SK66(6,6)
      COMMON/PSTIFB/SK99(9,9)
C
C
      DO 40 I=1,6
      I1=I+N
      GO TO (20,20,10,10,25,25),I
   10 I1=I+N+1
      GO TO 20
   25 I1=I+N+2
   20 DO 40 J=I,6
      J1=J+N
      GO TO (40,40,30,30,35,35),J
   30 J1=J+N+1
      GO TO 40
   35 J1=J+N+2
   40 SK99(I1,J1) = SK99(I1,J1) + SK66(I,J)
C
C PLACE UPPER TRIANGLE OF SK99 IN LOWER TRIANGLE OF SK99
C
      DO 50 I=1,8
      K=I+1
      DO 50 J=K,9
   50 SK99(J,I)=SK99(I,J)
      RETURN
      END
```

SUBROUTINE STORE

```
$IBFTC STORE*  DECK
      SUBROUTINE STORE(NTEST)
C TRANSFER ELEMENTS OF (INP) OR (OUTP) STIFFNESS IN THERE
C INTERMEDIATE MATRIX TO THEIR PROPER ELEMENTS IN SK(18,18)
C FOR THE QUADRILATERAL PLATE ANALYSIS, TRANSFER ELEMENTS
C OF SK(18,18) TO PROPER ELEMENTS OF SKQ(30,30).
      COMMON/PSTIF1/SK(18,18)
      COMMON/PSTIF8/SKQ(30,30)
      COMMON/PSTIF9/NP,N4
      COMMON/PSTIFB/SK99(9,9)
      COMMON/PSTIFK/NQUA
      COMMON/PSTRSS/SKQSS(30,30)
      COMMON/BUCK/IBUC
      COMMON/PREST/SKPRE(6)
C NTEST=2, FOR (INP)
C NTEST=0, FOR (OUTP)
      DO 70 I=1,9
      M=I/4
      IF(I.EQ.7)M=2
      I1=I+3*M+NTEST
      IF(NTEST)30,10,30
   10 GO TO(30,30,20,30,30,20,30,30,20),I
   20 I1=I1+3
   30 DO 70 J=1,9
      N=J/4
      IF(J.EQ.7)N=2
      J1=J+3*N+NTEST
      IF(NTEST)60,40,60
   40 GO TO(60,60,50,60,60,50,60,60,50),J
   50 J1=J1+3
   60 SK(I1,J1)=SK99(I,J)
   70 CONTINUE
      IF(NTEST.EQ.2) GO TO 200
C TRANSFER OF ELEMENTS FOR QUADRILATERAL
      IF(N4.NE.0)GO TO 80
      CALL MOVE(SK(1,1),SKQSS(1,1),18,18,18,30)
      GO TO 300
   80 CALL MOVE(SK(1,1),SKQSS(25,25),6,6,18,30)
      GO TO(90,110,130,150),NQUA
C 1ST SUBDIVIDED PLATE OF QUADRILATERAL
   90 CALL MOVE(SK(7,7),SKQSS(1,1),12,12,18,30)
      CALL MOVE(SK(1,7),SKQSS(25,1),6,12,18,30)
      CALL MOVE(SK(7,1),SKQSS(1,25),12,6,18,30)
      GO TO 300
C 2ND SUBDIVIDED PLATE OF QUADRILATERAL
  110 CALL MOVE(SK( 7, 7),SKQSS( 7, 7),6,6,18,30)
      CALL MOVE(SK(13, 7),SKQSS(19, 7),6,6,18,30)
      CALL MOVE(SK( 1, 7),SKQSS(25, 7),6,6,18,30)
      CALL MOVE(SK( 7,13),SKQSS( 7,19),6,6,18,30)
      CALL MOVE(SK(13,13),SKQSS(19,19),6,6,18,30)
      CALL MOVE(SK( 1,13),SKQSS(25,19),6,6,18,30)
      CALL MOVE(SK( 7, 1),SKQSS( 7,25),6,6,18,30)
      CALL MOVE(SK(13, 1),SKQSS(19,25),6,6,18,30)
      GO TO 300
C 3RD SUBDIVIDED PLATE OF QUADRILATERAL
  130 CALL MOVE(SK(13,13),SKQSS(13,13),6,6,18,30)
      CALL MOVE(SK( 7,13),SKQSS(19,13),6,6,18,30)
      CALL MOVE(SK( 1,13),SKQSS(25,13),6,6,18,30)
      CALL MOVE(SK(13, 7),SKQSS(13,19),6,6,18,30)
      CALL MOVE(SK( 7, 7),SKQSS(19,19),6,6,18,30)
      CALL MOVE(SK( 1, 7),SKQSS(25,19),6,6,18,30)
      CALL MOVE(SK(13, 1),SKQSS(13,25),6,6,18,30)
      CALL MOVE(SK( 7, 1),SKQSS(19,25),6,6,18,30)
      GO TO 300
C 4TH SUBDIVIDED PLATE OF QUADRILATERAL                                   1741
  150 CALL MOVE(SK(13,13),SKQSS( 1, 1),6,6,18,30)
      CALL MOVE(SK( 7,13),SKQSS(13, 1),6,6,18,30)
      CALL MOVE(SK( 1,13),SKQSS(25, 1),6,6,18,30)
      CALL MOVE(SK(13, 7),SKQSS( 1,13),6,6,18,30)
      CALL MOVE(SK( 7, 7),SKQSS(13,13),6,6,18,30)
      CALL MOVE(SK( 1, 7),SKQSS(25,13),6,6,18,30)
      CALL MOVE(SK(13, 1),SKQSS( 1,25),6,6,18,30)
      CALL MOVE(SK( 7, 1),SKQSS(13,25),6,6,18,30)
  300 IF(IBUC.EQ.0)GO TO 200
      SK( 6, 6)=SK( 6, 6)+SKPRE(1)
      SK(12, 6)=SK(12, 6)+SKPRE(2)
      SK(12,12)=SK(12,12)+SKPRE(3)
      SK(18, 6)=SK(18, 6)+SKPRE(4)
      SK(18,12)=SK(18,12)+SKPRE(5)
      SK(18,18)=SK(18,18)+SKPRE(6)
      SK(6,12) = SK(12,6)
      SK(6,18) = SK(18,6)
      SK(12,18) = SK(18,12)
      IF(N4.NE.0)GO TO 310
      CALL MOVE(SK(1,1),SKQ(1,1),18,18,18,30)                             1704
      GO TO 200                                                           1705
  310 CALL MOVE(SK(1,1),SKQ(25,25),6,6,18,30)                             1706
      GO TO(320,330,340,350),NQUA
  320 CALL MOVE(SK(7,7),SKQ(1,1),12,12,18,30)                             1712
      CALL MOVE(SK(1,7),SKQ(25,1),6,12,18,30)                             1713
      CALL MOVE(SK(7,1),SKQ(1,25),12,6,18,30)                             1714
      RETURN                                                              1715
  330 CALL MOVE(SK(7,7),SKQ(7,7),6,6,18,30)                               1719
      CALL MOVE(SK(13,7),SKQ(19,7),6,6,18,30)                             1720
      CALL MOVE(SK(1,7),SKQ(25,7),6,6,18,30)                              1721
      CALL MOVE(SK(7,13),SKQ(7,19),6,6,18,30)                             1722
      CALL MOVE(SK(13,13),SKQ(19,19),6,6,18,30)                           1723
      CALL MOVE(SK(1,13),SKQ(25,19),6,6,18,30)                            1724
      CALL MOVE(SK(7,1),SKQ(7,25),6,6,18,30)                              1725
      CALL MOVE(SK(13,1),SKQ(19,25),6,6,18,30)                            1726
      RETURN                                                              1727
  340 CALL MOVE(SK(13,13),SKQ(13,13),6,6,18,30)                           1731
      CALL MOVE(SK(7,13),SKQ(19,13),6,6,18,30)                            1732
      CALL MOVE(SK(1,13),SKQ(25,13),6,6,18,30)                            1733
      CALL MOVE(SK(13,7),SKQ(13,19),6,6,18,30)                            1734
      CALL MOVE(SK(7,7),SKQ(19,19),6,6,18,30)                             1735
      CALL MOVE(SK(1,7),SKQ(25,19),6,6,18,30)                             1736
      CALL MOVE(SK(13,1),SKQ(13,25),6,6,18,30)                            1737
      CALL MOVE(SK(7,1),SKQ(19,25),6,6,18,30)                             1738
      RETURN                                                              1739
  350 CALL MOVE(SK(13,13),SKQ(1,1),6,6,18,30)                             1743
      CALL MOVE(SK(7,13),SKQ(13,1),6,6,18,30)                             1744
      CALL MOVE(SK(1,13),SKQ(25,1),6,6,18,30)                             1745
      CALL MOVE(SK(13,7),SKQ(1,13),6,6,18,30)                             1746
      CALL MOVE(SK(7,7),SKQ(13,13),6,6,18,30)                             1747
      CALL MOVE(SK(1,7),SKQ(25,13),6,6,18,30)                             1748
      CALL MOVE(SK(13,1),SKQ(1,25),6,6,18,30)                             1749
      CALL MOVE(SK(7,1),SKQ(13,25),6,6,18,30)                             1750
  200 RETURN                                                              1751
      END                                                                 1752
```

SUBROUTINE MOVE

```
$IBFTC MOVE*   DECK
      SUBROUTINE MOVE(A,B,N1,N2,N3,N4)
C
C ADD ELEMENTS OF A TO B AND STORE IN B
C
      DIMENSION A(N3,1),B(N4,1)
C
      DO 10 J=1,N2
      DO 10 I=1,N1
   10 B(I,J)=B(I,J)+A(I,J)
      RETURN
      END
```

SUBROUTINE PMTR

```
$IBFTC PMTR*   DECK
      SUBROUTINE PMTR
C
C COORDINATE TRANSFORMATION MATRIX FOR TRIANGULAR PLATE AND QUADRILATERA
C
C
      COMMON/PMTR1/PT
      COMMON/PSTIF9/NP,N4
      COMMON/PSTIFG/XS1,YS1,ZS1,XS2,YS2,ZS2,XS3,YS3,ZS3,XS4,YS4,ZS4
C
C
C                    **** DEFINITION OF ARGUMENTS ****
C
C  XS1,YS1,ZS1 - STRUCTURAL COORDINATES AT NODE 1
C               FOR TRIANGULAR AND QUADRILATERAL PLATE
C  XS2,YS2,ZS2 - STRUCTURAL COORDINATES AT NODE 2
C               FOR TRIANGULAR AND QUADRILATERAL PLATE
C  XS3,YS3,ZS3 - STRUCTURAL COORDINATES AT NODE 3
C               FOR TRIANGULAR AND QUADRILATERAL PLATE
C  XS4,YS4,ZS4 - STRUCTURAL COORDINATES AT NODE 4 FOR QUADRILATERAL PLAT
C  PT - TRANSFORMATION MATRIX IN PARTITION FORM FOR
C       TRIANGULAR OR QUADRILATERAL PLATE
C
      DIMENSION PT(3,3),XX(3),YY(3),ZZ(3),D(3)
C
C THE FOLLOWING PROJECTIONS (LENGTHS) ARE USED TO COMPUTE
C DISTANCES BETWEEN NODES.
C
      XX(1) = XS2-XS1
      YY(1) = YS2-YS1
      ZZ(1) = ZS2-ZS1
C
      IF(N4.NE.0)GO TO 1
      XX(2) = XS3-XS1
      XX(3) = XS3-XS2
      YY(2) = YS3-YS1
      YY(3) = YS3-YS2
      ZZ(2) = ZS3-ZS1
      ZZ(3) = ZS3-ZS2
      GO TO 4
    1 XA = (XS4+XS3)/2.0
      YA = (YS4+YS3)/2.0
      ZA = (ZS4+ZS3)/2.0
      XX(2) = XA-XS1
      YY(2) = YA-YS1
      ZZ(2) = ZA-ZS1
C
C D(1) IS L21,ETC. WHERE L21 IS DISTANCE BETWEEN NODES 1 AND 2,ETC.
C
    4 DO 10 I=1,3
      IF(N4.EQ.0)GO TO 8
      IF(I.EQ.3) GO TO 20
    8 D(I) = SQRT(XX(I)**2 + YY(I)**2 + ZZ(I)**2)
   10 CONTINUE
C
C FORM UPPER LEFT PARTITION OF PT. (SHOWN ABOVE)
C
```

```
C  **************************************************
C
C  PT(1,1) IS L1, PT(1,2) IS L2, PT(1,3) IS L3
C  PT(2,1) IS M1, PT(2,2) IS M2, PT(2,3) IS M3
C  PT(3,1) IS N1, PT(3,2) IS N2, PT(3,3) IS N3
C
C  **************************************************
C
   20 PT(1,1) = XX(1)/D(1)
      PT(2,1) = YY(1)/D(1)
      PT(3,1) = ZZ(1)/D(1)
C
C DD IS (L31 X L32)
C
      IF(N4.NE.0)GO TO 40
      DD = D(2)*D(3)
      DL3 =(YY(2)*ZZ(3) - YY(3)*ZZ(2))/DD
      DM3 =(XX(2)*ZZ(3) - XX(3)*ZZ(2))/DD
      DN3 =(XX(2)*YY(3) - XX(3)*YY(2))/DD
      GO TO 50
   40 DL3 =(PT(2,1)*ZZ(2) - PT(3,1)*YY(2))/D(2)
      DM3 =(PT(1,1)*ZZ(2) - PT(3,1)*XX(2))/D(2)
      DN3 =(PT(1,1)*YY(2) - PT(2,1)*XX(2))/D(2)
   50 SQD=SQRT(DL3**2+DM3**2+DN3**2)
      PT(1,3) =   DL3/SQD
      PT(2,3) = - DM3/SQD
      PT(3,3) =   DN3/SQD
C
      PT(1,2) = PT(2,3)*PT(3,1) - PT(2,1)*PT(3,3)
      PT(2,2) = PT(1,1)*PT(3,3) - PT(3,1)*PT(1,3)
      PT(3,2) = PT(2,1)*PT(1,3) - PT(1,1)*PT(2,3)
C
C  **************************************************
C
      RETURN
      END
```

SUBROUTINE SMTR

```
$IBFTC SMTR*    DECK
      SUBROUTINE SMTR
      COMMON /PSTIF9/ NP,N4
      COMMON /PSTIFH/ XL1,YL1,XL2,YL2,XL3,YL3,XL4,YL4
      COMMON/STRAN/GQUAD(8,24)
      DIMENSION X(4),Y(4),XI(4),YI(4),NR(4),NU(4)
      DIMENSION Z(16)
      X(1)=XL1
      X(2)=XL2
      X(3)=XL3
      X(4)=XL4
      Y(1)=YL1
      Y(2)=YL2
      Y(3)=YL3
      Y(4)=YL4
      DO 3 I=1,8
      DO 1 J=1,24
    1 GQUAD(I,J)=0.0
    3 CONTINUE
      IF(N4.LE.0)GO TO 4
      XB=3.0*(X(4)*Y(3)-X(3)*Y(4)+X(2)*Y(4))
      XG=(X(4)+X(3))/3.0+(X(2)*Y(4)*(X(2)-X(3)))/XB
      YG=(Y(4)+Y(3))/3.0-X(2)*Y(4)*Y(3)/XB
      IF(X(2).EQ.X(4))GO TO 35
      YI(2)=Y(4)*(XG-X(2))/(X(4)-X(2))
      GO TO 36
   35 YI(2)=1.0E 20
   36 IF(X(4).EQ.X(3))GO TO 37
      YI(3)=(Y(4)-Y(3))*(XG-X(3))/(X(4)-X(3))+Y(3)
      GO TO 38
   37 YI(3)=1.0E+20
   38 IF(X(3).EQ.0.)GO TO 39
      YI(4)=Y(3)*XG/X(3)
      GO TO 40
   39 YI(4)=1.0E+20
   40 NT=4
      GO TO 5
    4 XG=(X(2)+X(3))/3.0
      YG=Y(3)/3.0
      IF(X(2).EQ.X(3))GO TO 45
      YI(2)=Y(3)*(XG-X(2))/(X(3)-X(2))
      GO TO 46
   45 YI(2)=1.0E 21
   46 IF(X(3).EQ.0.)GO TO 47
      YI(3)=Y(3)*XG/X(3)
      GO TO 48
   47 YI(3)=1.0E+20
   48 NT=3
    5 CONTINUE
      YT=1.0E 20
      YB=0
      DO 8 I=2,NT
      IF(YI(I).GT.YG)GO TO 6
      IF(YI(I).LE.YB)GO TO 8
      YB=YI(I)
      GO TO 8
    6 IF(YI(I).GT.YT)GO TO 8
```

```
      YT=YI(I)
    8 CONTINUE
      WY=YT-YB
      YC=(YT+YB)/2.0
      EIY=(WY**3)/12.0
      ELY=YC-YG
      JR=0
      DO 10 I=1,NT
      IF(X(I).LE.XG)GO TO 10
      JR=JR+1
      NR(JR)=I
   10 CONTINUE
      IF(N4.GT.0)GO TO 11
      XL=X(3)*YG/Y(3)
      XR=(X(3)-X(2))*YG/Y(3)+X(2)
      GO TO 15
   11 XI(1)=(X(4)-X(2))*YG/Y(4)+X(2)
      IF(Y(3).EQ.Y(4))GO TO 110
      XI(2)=(YG-Y(3))*(X(4)-X(3))/(Y(4)-Y(3))+X(3)
      GO TO 111
  110 XI(2)=1.0E 21
  111 XI(3)=X(3)*YG/Y(3)
      XR=1.0E 20
      XL=-1.0E 20
      DO 14 I=1,3
      IF(XI(I).GT.XG)GO TO 12
      IF(XI(I).LE.XL)GO TO 14
      XL=XI(I)
      GO TO 14
   12 IF(XI(I).GE.XR)GO TO 14
      XR=XI(I)
   14 CONTINUE
   15 CONTINUE
      WX=XR-XL
      XC=(XR+XL)/2.0
      EIX=(WX**3)/12.0
      ELX=XG-XC
      JT=0
      DO 16 I=3,NT
      IF(Y(I).LE.YG)GO TO 16
      JT=JT+1
      NU(JT)=I
   16 CONTINUE
      DO 17 J=1,JR
      K=(NR(J)-1)*6+3
      NJ=NR(J)
      GQUAD(1,K)=ELY/EIY
      GQUAD(1,K+1)=-(Y(NJ)-YC)*ELY/EIY+1.0/WY
      GQUAD(1,K+2)=(X(NJ)-XG)*ELY/EIY
      K=(NR(J)-1)*6+5
      GQUAD(3,K)=1.0/WY
      K=(NR(J)-1)*6+6
      GQUAD(4,K)=-1.0/WY
      K=(NR(J)-1)*6+2
      GQUAD(7,K)=-1.0/WY
      GQUAD(7,K+4)=(X(NJ)-XG)/WY
   17 CONTINUE
      DO 18 J=1,JT
      K=(NU(J)-1)*6+3
      NJ=NU(J)
      GQUAD(2,K)=ELX/EIX
      GQUAD(2,K+1)=-(Y(NJ)-YG)*ELX/EIX
      GQUAD(2,K+2)=(X(NJ)-XC)*ELX/EIX+1.0/WX
      K=(NU(J)-1)*6+6
      GQUAD(5,K)=-1.0/WX
      K=(NU(J)-1)*6+1
      GQUAD(6,K)=1.0/WX
      GQUAD(6,K+5)=(Y(NJ)-YG)/WX
      K=(NU(J)-1)*6+2
      GQUAD(8,K)=1.0/WX
      GQUAD(8,K+4)=-(X(NJ)-XG)/WX
   18 CONTINUE
   30 RETURN
      END
```

SUBROUTINE LOCAL

```
$IBFTC LOCAL*  DECK
      SUBROUTINE LOCAL
C
C FORM LOCAL COORDINATES FROM STRUCTURAL COORDINATES
C FOR TRIANGULAR OR QUADRILATERAL PLATE
C
      COMMON/RENT/NRENT,KRENT
      COMMON/PSTIF9/NP,N4
      COMMON/PSTIFG/XS1,YS1,ZS1,XS2,YS2,ZS2,XS3,YS3,ZS3,XS4,YS4,ZS4
      COMMON/PSTIFH/XL1,YL1,XL2,YL2,XL3,YL3,XL4,YL4
      COMMON/PSTIFL/ISWAP
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
C
      D(D1,D2,D3,D4,D5,D6)=(D1-D2)**2+(D3-D4)**2+(D5-D6)**2
C
C GENERATION OF LOCAL COORDINATES FOR FIRST THREE NODES IS THE
C SAME FOR TRIANGULAR AND QUADRILATERAL PLATES
C
C D21 IS THE DISTANCE SQUARED BETWEEN NODES 2 AND 1 FOUND FROM
C STRUCTURAL COORDINATES, ETC.
C
      IOUT = MT6
      D21 = D(XS2,XS1,YS2,YS1,ZS2,ZS1)
      D31 = D(XS3,XS1,YS3,YS1,ZS3,ZS1)
      D32 = D(XS3,XS2,YS3,YS2,ZS3,ZS2)
      ISWAP =0
      KRENT=0
C
C NODE 1
C
      XL1=0.0
      YL1=0.0
C
C NODE 2
C
      XL2=SQRT(D21)
      YL2=0.0
C
C NODE 3
C
      XL3=(D31-D32+D21)/(2.0*XL2)
      YL3=SQRT(D31-XL3**2)
C
C NODE 4
C
      IF(N4.EQ.0)GO TO 50
   40 D41 = D(XS4,XS1,YS4,YS1,ZS4,ZS1)
      D42 = D(XS4,XS2,YS4,YS2,ZS4,ZS2)
      D43=D(XS4,XS3,YS4,YS3,ZS4,ZS3)
      XL4=(D41-D42+D21)/(2.0*XL2)
      YL4=SQRT(D41-XL4**2)
      D43L=     ((XL4-XL3)**2+(YL4-YL3)**2)
      IF(ABS(D43-D43L).GE..10*D43)GO TO 44
C
C CHECK SEQUENCE OF LOCAL COORDINATES OF QUADRILATERAL PLATE
C
```

```
      IF ((XL4*YL3)-(XL3*YL4)) 42,4,4
C
C SWAP COORDINATES FOR NODES 3 AND 4
C
   42 ISWAP=1
      RETURN
C
C CHECK FOR REENTRANT CORNER
C
    4 CONTINUE
      X32 = XL3 - XL2
      X42 = XL4 - XL2
      IF ((X42*YL3)-(X32*YL4)) 44,50,50
   44 WRITE(IOUT,1000)NP,XL1,XL2,XL3,XL4,YL1,YL2,YL3,YL4
      NRENT =1
      KRENT=1
   50 RETURN
 1000 FORMAT(25H QUADRILATERAL PLATE NO. ,I4,
     *23H HAS A REENTRANT CORNER/23H0LOCAL COORDINATES ARE,/
     *14H0X-COORDINATES,4(3X,E15.8)/14H0Y-COORDINATES,4(3X,E15.8))
      END
```

SUBROUTINE COPLAN

```
$IBFTC COPLA*  DECK
      SUBROUTINE COPLAN(NERR)
C
C DETERMINE THE DEGREE OF COPLANARTY
C
      COMMON/PSTIF9/NP,N4
      COMMON/PSTIFG/XS1,YS1,ZS1,XS2,YS2,ZS2,XS3,YS3,ZS3,XS4,YS4,ZS4
      COMMON/PSTIFH/XL1,YL1,XL2,YL2,XL3,YL3,XL4,YL4
      COMMON/NOMERG/INER
      COMMON/CHECK/ACPT,GROSS
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
C
C ACPT - ACCEPTABLE PERCENT OF NONCOPLANARITY OF QUADRILATERAL PLATE
C GROSS - NOT ACCEPTABLE PERCENT OF NONCOPLANARITY OF QUADRILATERAL PLAT
C
      IOUT = MT6
      NERR=0
      RTD43=SQRT((XS4-XS3)**2+(YS4-YS3)**2+(ZS4-ZS3)**2)
      PERCT=(100.0*(RTD43-SQRT((XL4-XL3)**2+(YL4-YL3)**2)))/RTD43
C
C TEST FOR EXCEPTABLE ERROR WITH NO COMMENT
C
      IF(ABS(PERCT).LE.ACPT) GO TO 50
C
C TEST FOR MINOR OR GROSS ERROR WITH COMMENT
C
      IF(ABS(PERCT).GE.GROSS) GO TO 40
C
C MINOR ERROR - CONTINUE ANALYSIS
C
      WRITE(IOUT,1000)NP,PERCT
      GO TO 50
C
C GROSS ERROR - DELETE ANALYSIS
C
   40 NERR=1
      INER=1
      WRITE(IOUT,1001)NP,PERCT
   50 RETURN
 1000 FORMAT(25H0QUADRILATERAL PLATE NO. ,I4/
     *9X,25HDEGREE OF NONCOPLANARITY ,F6.3,8H PERCENT/
     *9X,31HACCEPTABLE - ANALYSIS CONTINUED)
 1001 FORMAT(25H0QUADRILATERAL PLATE NO. ,I4/
     *9X,25HDEGREE OF NONCOPLANARITY ,F8.3,8H PERCENT/
     *9X,33HNOT ACCEPTABLE - ANALYSIS DELETED)
      END
```

SUBROUTINE BEAM

```
$IBFTC BEAM*    DECK
      SUBROUTINE BEAM                                                       222
      COMMON/TITL/TITLE(13)
C                                                                           222
      DIMENSION XL(50),TEMP(50)
      DIMENSION PROP(600),FLX(6,6),SKAB(6,6),GAM1(6,6),GAM2(6,6),
     2AK(12,12),Q(12,12),BK(12,12),TLAM(12,12),GAMMA(12,12),QG(12,12),      222
     3OFSET(6),JFIX(6),ALAM(6,6),ALAMA(6,6),ALAMB(6,6),ALSL(6,6),           222
     4XKG(12,12)
C                                                                           223
      COMMON/CONT1/JPART(800)                                               223
      COMMON/CONT2/KPART(800)                                               223
      COMMON/LASTND/LN(200)                                                 223
      COMMON/CORD/XN(2000),YN(2000),ZN(2000)                                223
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,IPT,NPS ,IUM2                   223
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
C                                                                           224
      COMMON/PROPT/YI(100),ZA(100),XA(100),ZI(100),YA(100),GJ(100)          224
      COMMON/ADPRO/EM,G,RC,ALFA,DARC,DL                                     224
      COMMON/SSTR/EMM,GG                                                    224
      COMMON/VAR/NPTS,FNPTS                                                 224
      COMMON/N3N3/N3                                                        224
      COMMON/FLAG/NFLAG                                                     224
C                                                                           224
      EQUIVALENCE(PROP,YI)                                                  224
C                                                                           225
      IN = MT5
      IOUT = MT6
      ISTRS = MT16
      ISTIF = MT2
      NPTS=100                                                              225
      FNPTS=100.0                                                           225
      K1=NPS+1                                                              225
C                                                                           225
C                                                                           226
C                                                                           226
 1999 CONTINUE                                                              226
      NB=0                                                                  226
      LINE=0
      WRITE(IOUT,9011)(II,II=1,3)

C*****NB COUNTS BEAMS

 2001 NB=NB+1                                                               226
      ILOAD=0                                                               227
C                                                                           227

C****** READ BEAM DATA                                                      BEA

      RC=0.
      READ(IN,9030)KB,N1,N2,N3,ISP,NSP,IOC,IOFSET,
     1IFRC,(JFIX(K),K=1,6),IBUC,EM,G
      IF(IBUC.NE.0)READ(IN,9090)SK,SSK
      IF((IBUC.NE.0) .AND. (SK .NE. 0.0)) WRITE(IOUT,9351) SK
      IF((IBUC .NE. 0) .AND. (SSK .NE. 0.0)) WRITE(IOUT,9351) SSK
      IF(IFRC.NE.0)  READ(IN,9090) RC
      DO 16 K=1,6
   16 JFIX(K)=IABS(JFIX(K))
C                                                                       227

C*****CHECK RANGE OF NODES

      IF(NNODE-N1     )25,20,20                                         227
   20 IF(NNODE-N2     )25,30,30                                         227
   25 WRITE (IOUT,9050)KB                                               227
      NFLAG=1                                                           227

C****** CHECK VALIDITY OF DATA

   30 IF(EM)35,40,45                                                    228
   35 WRITE(IOUT,9060)KB                                                228
      EM=ABS(EM)                                                        228
      GO TO 45                                                          228
   40 EM=EMM                                                            228
   45 IF(G)50,55,60                                                     228
   50 WRITE(IOUT,9070)KB                                                228
      G=ABS(G)                                                          228
      GO TO 60                                                          228
   55 G=GG                                                              228
   60 IF(KB     -NB)54,70,54                                            229
   54 WRITE(IOUT,9080)KB     ,NB                                        229
      CALL EXIT                                                         229
C                                                                       229
C     OFFSET NODES                                                      229
C                                                                       229
   70 IF(IOFSET)56,57,56                                                229
C                                                                       229
   56 READ  (IN,9090)(OFSET(I),I=1,6)                                   229
C                                                                       229
      GO TO 59                                                          230
   57 DO 58 I=1,6                                                       230
   58 OFSET(I)=0.0                                                      230
   59 M=N1                                                              230
      X1=XN(M)+OFSET(1)                                                 230
      Y1=YN(M)+OFSET(2)                                                 230
      Z1=ZN(M)+OFSET(3)                                                 230
      XA1=ABS(XN(M))                                                    230
      YA1=ABS(YN(M))                                                    230
      ZA1=ABS(ZN(M))                                                    230
      M=N2                                                              231
      X2=XN(M)+OFSET(4)                                                 231
      Y2=YN(M)+OFSET(5)                                                 231
      Z2=ZN(M)+OFSET(6)                                                 231
      XA2=ABS(XN(M))                                                    231
      YA2=ABS(YN(M))                                                    231
      ZA2=ABS(ZN(M))                                                    231
      M=N3                                                              231
      X3=XN(M)                                                          231
      Y3=YN(M)                                                          231
      Z3=ZN(M)                                                          232
C                                                                       232

C*****COMPUTE OFFSET TRANSFORMATION MATRIX

      IF(IOFSET.NE.0) CALL OFST(OFSET,GAMMA,GAM1,GAM2)                  232
C                                                                       232
```

```
C
C     CONNECTIVITY INFO FOR BEAM
C
C
      MPT=IPT-1
      DO 65 I=1,MPT
      IF((N1.LE.LN(I+1)).AND.(N1.GT.LN(I)))NI=I+1
      IF((N2.LE.LN(I+1)).AND.(N2.GT.LN(I)))NJ=I+1

C*****N1 IS IN THE NI-TH PARTITION
C*****N2 IS IN THE NJ-TH PARTITION

      IF(N1.LE.LN(1))NI=1
      IF(N2.LE.LN(1))NJ=1
   65 CONTINUE
C
      IF(NI.GE.NJ)NINJ=NI*1000+NJ
      IF(NJ.GT.NI) NINJ=NJ*1000+NI
      NINI=1001*NI
      NJNJ=1001*NJ
C
C
      K11=K1-1
      KC=0
      KC1=0
      KC2=0
C

C*****K1 COUNTS PARTITIONS
C*****FIRST DIGIT OF KPART = FIRST BEAM IN THE PARTITION
C***** LAST DIGIT OF KPART = LAST BEAM IN THE PARTITION

      DO 66 I=1,800
      IF(JPART(+).EQ.NINJ)KC=I
      IF(JPART(I).EQ.NINI)KC1=I
      IF(JPART(I).EQ.NJNJ)KC2=I
   66 CONTINUE
C
      IF(KC.EQ.0)GO TO 81

C*****UPDATE KPART

      IF(KPART(KC ).EQ.0) KPART(KC )=10001*KB
      KPART(KC )=(KPART(KC )/10000)*10000+KB
      GO TO 82
   81 CONTINUE

C*****NEW PARTITION - COMPUTE JPART, KPART

      JPART(K1)=NINJ
      KPART(K1 )=10001*KB
      K1=K1+1
   82 IF(KC1.EQ.0)GO TO 83

C*****UPDATE KPART

      IF(KPART(KC1).EQ.0) KPART(KC1)=10001*KB
      KPART(KC1)=(KPART(KC1)/10000)*10000+KB
      GO TO 84
   83 CONTINUE
```

```
C*****DON'T COUNT PARTITION AGAIN IF ALREADY COUNTED

      IF(NINJ.EQ.NINI)GO TO 67                                          236

C*****NEW PARTITION - COMPUTE JPART, KPART

      JPART(K1)=NINI                                                    236
      KPART(K1 )=10001*KB                                               236
      K1=K1+1                                                           236
   67 CONTINUE                                                          237
   84 IF(KC2.EQ.0)GO TO 85                                              237

C*****UPDATE KPART

      IF(KPART(KC2).EQ.0) KPART(KC2)=10001*KB                           237
      KPART(KC2)=(KPART(KC2)/10000)*10000+KB                            237
      GO TO 86                                                          237
   85 CONTINUE                                                          237

C*****DON'T COUNT PARTITION AGAIN IF ALREADY COUNTED

      IF((NJNJ.EQ.NINI).OR.(NJNJ.EQ.NINJ))GO TO 71                      237

C*****NEW PARTITION - COMPUTE JPART, KPART

      JPART(K1)=NJNJ                                                    237
      KPART(K1 )=10001*KB                                               237
      K1=K1+1                                                           237
   71 CONTINUE                                                          238
   86 CONTINUE                                                          238
C                                                                       238
C     SECTION PROPERTIES                                                238
C                                                                       238
      IF(ISP)75,810,75
C                                                                       238
   75 NCT=0                                                             238
      NI=0                                                              238
      GO TO(80,90,130),ISP                                              238
C                                                                       239

C****** UNIFORM PROPERTIES

   80 READ  (IN,9090)YI(1),ZA(1),XA(1),ZI(1),YA(1),GJ(1)                239
  810 WRITE(IOUT,9012)KB,N1,N2,N3,JFIX,YI(1),ZA(1),XA(1),ZI(1),YA(1),
     1   GJ(1),EM,G
      LINE=LINE+1
      IF(LINE.LT.50)GO TO 803
      LINE=0
      CALL PAGHED
      WRITE(IOUT,9011)(II,II=1,3)
  803 CONTINUE
      IF(IOFSET.EQ.0) GO TO 802
      WRITE(IOUT,9014)(OFSET(I),I=1,6)
      LINE=LINE+1
      IF(LINE.LT.50)GO TO 802
      LINE=0
      CALL PAGHED
      WRITE(IOUT,9011)(II,II=1,3)
  802 CONTINUE
```

```
      IF(ISP.EQ.0) GO TO 190
C
      DO 89 I=2,100
      PROP(I)=YI(1)
      PROP(I+100)=ZA(1)
      PROP(I+200)=XA(1)
      PROP(I+300)=ZI(1)
      PROP(I+400)=YA(1)
   89 PROP(I+500)=GJ(1)
      GO TO 190
C
C****** PROPERTIES VARY ACCORDING TO FORMULA

   90 DO 125 I=1,6
      LL=100*I
      KK=LL-99
      IF(NI-I)95,100,115
C
   95 READ  (IN,9150)NI,K,L,M,N,A,B,C
      WRITE(IOUT,9016)KB,N1,N2,N3,JFIX,NI,K,L,M,N,A,B,C
      LINE=LINE+1
      IF(LINE.LT.50)GO TO 804
      LINE=0
      CALL PAGHED
      WRITE(IOUT,9011)(II,II=1,3)
  804 CONTINUE
C
      IF(NI-I)126,100,115
  100 AJ=-.005
      NCT=NCT+1
      DO 105 J=KK,LL
      AJ=AJ+.01
      PROP(J)=C*(1.0+A*(AJ)**K)**M*(1.0+B*(AJ)**L)**N
  105 CONTINUE
      IF(NCT-NSP)125,110,125
  110 NI=7
      GO TO 125
  115 DO 120 J=KK,LL
      PROP(J)=0.0
  120 CONTINUE
  125 CONTINUE
C
      GO TO 190
  126 WRITE (IOUT,9160)NI
      CALL EXIT
C
C****** PROPERTIES VARY ACCORDING TO TABLE

  130 DO 185 K=1,6
      LL=100*K
      KK=LL-99
      IF(NI-K)135,140,175
C
  135 READ  (IN,9010)NI,LTBL,BL
C
      IF(NI-K)126,140,175
C
  140 READ  (IN,9090)(XL(J),TEMP(J),J=1,LTBL)
```

```
      WRITE(IOUT,9017)KB,N1,N2,N3,JFIX,(XL(J),TEMP(J),J=1,LTBL)
      LINE=LINE+1
      IF(LINE.LT.50)GO TO 805
      LINE=0
      CALL PAGHED
      WRITE(IOUT,9011)(II,II=1,3)
  805 CONTINUE
C
      DO 141 I=1,LTBL
  141 XL(I)=XL(I)/BL
      DELT=-.005
      I=2
      DO 165 J=KK,LL
      DELT=DELT+.01
  145 IF(DELT-XL(I))150,155,160
  150 PROP( J)=TEMP(I)-((TEMP(I)-TEMP(I-1))*(XL(I)-DELT)/
     1(XL(I)-XL(I-1)))
      GO TO 165
  155 PROP(J)=TEMP(I)
      GO TO 165
  160 I=I+1
      GO TO 145
  165 CONTINUE
      NCT=NCT+1
      IF(NCT-NSP)185,170,185
  170 NI=7
      GO TO 185
  175 CONTINUE
      DO 180 L=KK,LL
  180 PROP(L)=0.0
  185 CONTINUE
C
  190 CONTINUE
C

C****** COMPUTE TRANSFORMATION AND STIFFNESS MATRICES

C
      IF(RC)205,200,205
C
C
 200  CALL SBMTR(X1,Y1,Z1,X2,Y2,Z2,X3,Y3,Z3,ALAM,TLAM)
      CALL SSTIF(AK)
      GO TO 206
C
  205 CALL CBMTR(X1,Y1,Z1,X2,Y2,Z2,X3,Y3,Z3,ALAMA,ALAMB,TLAM)
      CALL CSTIF(AK,FLX,SKAB)
C
  206 CONTINUE
C
      IF(IBUC.NE.0) CALL SBGS(SK,SSK,DL,XKG)
      IF(IBUC.NE.0) CALL MAD(AK,XKG)
C
C
      DO 201 I=1,6
      DO 201 L=1,6
      SKAB(I,L)=AK(I,L+6)
  201 FLX(I,L)=AK(I+6,L+6)
C
  591 DO 208 I=1,6
```

```
      IF(JFIX(I).NE.1)GO TO 208                                         248
      M=I                                                               248
      IF(I.GT.3)M=I+3                                                   248
      CALL REDUCE(AK,12,M)
  208 CONTINUE                                                          248
  710 CONTINUE                                                          280
      IF(IOFSET)210,209,210                                             248
C                                                                       248
  209 CONTINUE                                                          249
      CALL MULT(AK,TLAM,Q,12,12,12,1,0)                                 249
      CALL MULT(TLAM,Q,BK,12,12,12,2,0)                                 249
      GO TO 211                                                         249
C                                                                       249
  210 CONTINUE                                                          249
      CALL MULT(TLAM,GAMMA,QG,12,12,12,1,0)                             2 9
      CALL MULT(AK,QG,Q,12,12,12,1,0)                                   249
      CALL MULT(QG,Q,BK,12,12,12,2,0)                                   249
C                                                                       249
  211 CONTINUE                                                          250
C                                                                       250
C     ENGINEERING SIGN CONVENTION                                       250
      DO 213 I=1,12                                                     250
      Q(1,I)=-Q(1,I)                                                    250
      Q(3,I)=-Q(3,I)                                                    250
      Q(4,I)=-Q(4,I)                                                    250
      Q(8,I)=-Q(8,I)                                                    250
      Q(11,I)=-Q(11,I)                                                  250
      Q(12,I)=-Q(12,I)                                                  250
  213 CONTINUE                                                          251
C                                                                       251
C                                                                       251
C                                                                       251
C     WRITING STRESS MATRIX                                             251
C                                                                       251
      WRITE(ISTRS)KB,N1,N2                                              251
      WRITE(ISTRS)((Q(I,J),I=1,12),J=1,12)                              251
C                                                                       251
C                                                                       251
C                                                                       252
C     WRITING STIFFNESS MATRIX                                          252
C                                                                       252
      WRITE(ISTIF)N1,N2                                                 252
C                                                                       252
      WRITE(ISTIF)((BK(J,I),J=1,6),I=1,6) ,                             252
     1((BK(J,I),J=1,6),I=7,12),((BK(J,I),J=7,12),I=1,6),                252
     2((BK(J,I),J=7,12),I=7,12)                                         252
C                                                                       252
C                                                                       281
C                                                                       281
      IF(IOC.EQ.0)GO TO 1950                                            281
C                                                                       281
      WRITE(IOUT,9320)                                                  281
      CALL PRINT(TLAM,12,12,1,4HTLAM,1,12)                              281
      WRITE (IOUT,9270)                                                 281
      CALL PRINT(AK,12,12,1,4HAK   ,1,12)                               281
      WRITE (IOUT,9310)                                                 281
      CALL PRINT(Q,12,12,1,4HQ    ,1,12)                                281
      WRITE (IOUT,9300)                                                 282
      CALL PRINT(BK,12,12,1,4HBK   ,1,12)                               282
 1950 CONTINUE                                                          282
```

```
C                                                                          282
 2000 IF(NBEAM-NB)2002,2002,2001                                           282
C                                                                          282
C                                                                          283
 2002 CONTINUE                                                             283
      NPS=K1-1                                                             283
C                                                                          283
C                                                                          284
 9010 FORMAT(2I4,4X,E12.4)
 9011 FORMAT(/56X,9HBEAM DATA//
     1 1X,    5H BEAM,3(5H NODE ),4X,6HFIXITY,4X,4HI(Y),8X,5HA(XY),9X,
     21HA,9X,4HI(Z),8X,5HA(XZ),9X,1HJ,9X,6HYG MOD,6X,6HSH MOD//4X,3I5//)
 9012 FORMAT(4I5,4X,6I1,8(1PE12.3))
 9013 FORMAT(9H RADIUS =E14.4)
 9014 FORMAT(9H OFFSETS 6E12.4)
 9016 FORMAT(4I5,4X,6I1,10H PROPERTY I1,16H   CONSTANTS  K=I5,3H L=I5,
     1  3H M=I5,3H N=I5,3H A=1PE11.3,3H B=1PE11.3,3H C=1PE11.3)
 9017 FORMAT(4I5,4X,6I1,10H PROPERTY I1,3(3H X=E12.4,5H VAL=E12.4))
 9030 FORMAT(8I4,4X,I4,6I1,I2,2E12.4)
 9050 FORMAT(33H1INCORRECT NODE NUMBER, BEAM NO. I3)                       284
 9060 FORMAT(42H1NEGATIVE MODULUS OF ELASTICITY, BEAM NO. I3)              284
 9070 FORMAT(40H1NEGATIVE MODULUS OF RIGIDITY, BEAM NO. I3)                284
 9080 FORMAT(40H1INPUT NOT IN PROPER SEQUENCE, BEAM NO. I3,                285
     111H SHOULD BE I3)                                                    285
 9090 FORMAT(6E12.4)                                                       285
 9150 FORMAT(5I4,4X,3E12.4)
 9160 FORMAT(1H117HSECTION PROPERTY I1,18HIS OUT OF SEQUEN3E)              285
 9170 FORMAT(3I4,5E12.4)                                                   285
 9190 FORMAT(E12.4,4I4)                                                    285
 9270 FORMAT(23H1LOCAL STIFFNESS MATRIX)                                   285
 9290 FORMAT(29H1OFFSET TRANSFORMATION MATRIX)                             286
 9300 FORMAT(28H1STRUCTURAL STIFFNESS MATRIX)                              286
 9310 FORMAT(14H1STRESS MATRIX)                                            286
 9320 FORMAT(22H1TRANSFORMATION MATRIX)                                    286
 9350 FORMAT(1H I4,6E12.4)                                                 286
 9351 FORMAT(20H0INITIAL BEAM THRUST,F10.2,5H LBS.//)
C                                                                          286
      RETURN                                                               286
      END                                                                  286
```

SUBROUTINE TINVR

```
$IBFTC TINVR*  DECK
      SUBROUTINE TINVR (ELEM,N,IND)
      DIMENSION ELEM(6,6)
      CALL OVERFL(K000FX)
       GO TO(99,99),K000FX
 99   CALL DVCHK (K000FX)
       GO TO(100,100),K000FX
C     COMPUTE EQUIVALENT TRIANGULAR MATRIX
 100  DO 111 I=1,N
      IF (ELEM(I,I)) 107,107,108
 107  IND=-1
      GO TO 310
 108  ELEM(I,I)=SQRT(ELEM(I,I))
      L=I+1
      IF (L-N) 103,103,116
 103  DO 102 J=L,N
 102  ELEM(J,I)=ELEM(I,J)/ELEM(I,I)
      CALL DVCHK (K000FX)
       GO TO(107,106),K000FX
 106  DO 111 K=L,N
      IF (ELEM(K,I))112,111,112
 112  DO 110 J=K,N
 110  ELEM(K,J)=ELEM(K,J)-ELEM(K,I)*ELEM(J,I)
 111  CONTINUE
C     INVERT TRIANGULAR MATRIX
 116  M=N-1
      DO 198 J=1,M
      L=J+1
      DO 198 K=L,N
 198  ELEM(J,K)=0.0
      DO 199 I=1,N
 199  ELEM(I,I)=1.0/ELEM(I,I)
      DO 206 I=1,M
      L=I+1
      DO 206 J=L,N
      M=J-1
      DO 204 K=I,M
 204  ELEM(I,J)=ELEM(I,J)-ELEM(J,K)*ELEM(I,K)
 206  ELEM(I,J)=ELEM(J,J)*ELEM(I,J)
      CALL OVERFL(K000FX)
       GO TO(200,207),K000FX
 200  IND=-2
      GO TO 310
C     EXPAND TRIANGULAR INVERSE
 207  DO 299 I=2,N
      L=I-1
      DO 299 J=1,L
 299  ELEM(I,J)=0.0
      DO 306 I=1,N
      DO 306 J=I,N
      E=0.0
      DO 305 K=J,N
 305  E=E+ELEM(I,K)*ELEM(J,K)
 306  ELEM(J,I)=E
      DO 307 I=2,N
      L=I-1
      DO 307 J=1,L
```

```
307   ELEM(J,I)=ELEM(I,J)
      CALL OVERFL(K000FX)
       GO TO(300,308),K000FX
300   IND=-3
      GO TO 310
308   IND=+1
 310 RETURN
      END
```

SUBROUTINE SMULT

```
$IBFTC SMULT*  DECK
      SUBROUTINE SMULT(A,B,C,N1,N2,N3)
C
      DIMENSION A(N1,N2),B(N2,N3),C(N1,N3)
C
C     C=C-A*B
C     WHERE C IS AN N1*N3
C           A IS AN N1*N2
C           B IS AN N2*N3
C
      DO 100 I=1,N1
      DO 100 J=1,N3
      C(I,J)=0.0
      DO 100 K=1,N2
      C(I,J)=C(I,J)-A(I,K)*B(K,J)
  100 CONTINUE
C
      RETURN
      END
```

SUBROUTINE MULT

```
$IBFTC MULT*    DECK
      SUBROUTINE MULT(A,B,C,N1,N2,N3,N4,IM )
C     N1,N2,AND N3 MUST BE IN THEIR ORDER AFTER TRANSPOSITION
      DIMENSION A(N1,N2),B(N2,N3),C(N1,N3)
C     N4=1...NORMAL
C     N4=2...(A(TRANSPOSE))*B
C
C     C=C+A*B
C     WHERE C IS AN N1*N3
C           A IS AN N1*N2
C           B IS AN N2*N3
C
C     IM=0 NORMAL
C       =1 MOVE C TO B
C
      GO TO(1,2),N4
C
    2 CONTINUE
      DO 10 I=1,N1
      DO 10 J=1,N3
      C(I,J)=0.0
      DO 10 K=1,N2
      C(I,J)=C(I,J)+A(K,I)*B(K,J)
   10 CONTINUE
      GO TO 98
    1 CONTINUE
      DO 100 I=1,N1
      DO 100 J=1,N3
      C(I,J)=0.0
      DO 100 K=1,N2
      C(I,J)=C(I,J)+A(I,K)* B(K,J)
  100 CONTINUE
   98 CONTINUE
      IF(IM)300,200,300
  200 RETURN
  300 DO 320 I=1,N1
      DO 320 J=1,N3
      B(I,J)=C(I,J)
  320 CONTINUE
      GO TO 200
      END
```

SUBROUTINE SBMTR

```
$IBFTC SBMTR*  DECK
      SUBROUTINE SBMTR(XI,YI,ZI,XF,YF,ZF,XC,YC,ZC,ALAM,SLAM)
C
C     STRAIGHT BEAM TRANSFORMATION MATRIX
C
      DIMENSION ALAM(6,6),SLAM(12,12)
C
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/VAR/NPTS,FNPTS
      COMMON/ADPRO/EM,G,RC,ALFA,DARC,DL
      COMMON/N3N3/N3
C
      XFI=XF-XI
      YFI=YF-YI
      ZFI=ZF-ZI
      DS=SQRT(XFI**2+YFI**2)
      DL=SQRT(XFI**2+YFI**2+ZFI**2)
      DARC=DL/FNPTS
C
      IOUT = MT6
      IF(N3.EQ.0)GO TO 5
      XCI=XC-XI
      YCI=YC-YI
      ZCI=ZC-ZI
      F=(XCI*XFI+YCI*YFI)/DS
      B=-(XCI*YFI-YCI*XFI)/DS
      D=(-F*ZFI+ZCI*DS)/DL
      DIV=SQRT(D*D+B*B)
      DIVR=SQRT(XCI**2+YCI**2)
    5 CONTINUE
C
      DO 10 I=1,6
      DO 10 J=1,6
   10 ALAM(I,J)=0.0
C
      DO 15 I=1,12
      DO 15 J=1,12
   15 SLAM(I,J)=0.0
C
      IF(DS)20,40,60
C
   20 WRITE(IOUT,9000)XI,YI,ZI,XF,YF,ZF
 9000 FORMAT(19H1LENGTH IS NEGATIVE///(6E10.3))
C
   40 CONTINUE
      IF(N3.NE.0)GO TO 41
      SINB=0.
      COSB=1.
      GO TO 42
   41 SINB=YCI/DIVR
      COSB=XCI/DIVR
   42 ALAM(1,3)=ZFI/DL
      ALAM(2,1)=SINB*(ZFI/DL)
      ALAM(2,2)=-COSB*(ZFI/DL)
      ALAM(3,1)=COSB
      ALAM(3,2)=SINB
      GO TO 65
C
   60 CONTINUE
      IF(N3.NE.0) GO TO 61
      SINB=0.
      COSB=1.
      GO TO 62
   61 COSB=D/DIV
      SINB=B/DIV
   62 ALAM(1,1)=XFI/DL
      ALAM(1,2)=YFI/DL
      ALAM(1,3)=ZFI/DL
      ALAM(2,1)=-COSB*(YFI/DS)+SINB*(ZFI/DL)*(XFI/DS)
      ALAM(2,2)=COSB*(XFI/DS)+SINB*(ZFI/DL)*(YFI/DS)
      ALAM(2,3)=-SINB*(DS/DL)
      ALAM(3,1)=-SINB*(YFI/DS)-COSB*(ZFI/DL)*(XFI/DS)
      ALAM(3,2)=SINB*(XFI/DS)-COSB*(ZFI/DL)*(YFI/DS)
      ALAM(3,3)=COSB*(DS/DL)
C
   65 CONTINUE
C
      DO 90 I=1,3
      DO 90 J=1,3
      ALAM(I+3,J+3)=ALAM(I,J)
   90 CONTINUE
C
      DO 110 I=1,6
      DO 110 J=1,6
      SLAM(I,J)=ALAM(I,J)
      SLAM(I+6,J+6)=ALAM(I,J)
  110 CONTINUE
C
      RETURN
      END
```

SUBROUTINE SSTIF

```
$IBFTC SSTIF*  DECK
      SUBROUTINE SSTIF(AK)
C                                                                       3067
C     STRAIGHT BEAM STIFFNESS                                           3068
C                                                                       3069
      DIMENSIONAK(12,12)
C                                                                       3071
      COMMON/VAR/NPTS,FNPTS                                             3075
      COMMON/ADPRO/EM,G,RC,ALFA,DARC,DL                                 3076
      COMMON/PROPT/YI(100),ZA(100),XA(100),ZI(100),YA(100),GJ(100)      3077
C                                                                       3078
C                                                                       3079
      YSUM1=0.0                                                         3080
      YSUM2=0.0                                                         3081
      YSUM3=0.0                                                         3082
      YSUM4=0.0                                                         3083
      ZSUM1=0.0                                                         3084
      ZSUM2=0.0                                                         3085
      ZSUM3=0.0                                                         3086
      ZSUM4=0.0                                                         3087
      SUM5=0.0                                                          3088
      SUM6=0.0                                                          3089
      A=0.0                                                             3090
      B=201.0                                                           3091
      C=-1.0                                                            3092
      S=DL                                                              3093
C                                                                       3094
      DO 100 I=1,12                                                     3095
      DO 100 J=1,I                                                      3096
  100 AK(I,J)=0.0                                                       3097
C                                                                       3098
      DO 200 I=1,NPTS                                                   3099
      A=A+1.0                                                           3100
      B=B-2.0                                                           3101
      C=C+2.0                                                           3102
      YSUM1=YSUM1+B**2/ZI(I)                                            3103
      YSUM2=YSUM2+1.0/YA(I)                                             3104
      YSUM3=YSUM3+C**2/ZI(I)                                            3105
      YSUM4=YSUM4+C*B/ZI(I)                                             3106
      ZSUM1=ZSUM1+B**2/YI(I)                                            3107
      ZSUM2=ZSUM2+1.0/ZA(I)                                             3108
      ZSUM3=ZSUM3+C**2/YI(I)                                            3109
      ZSUM4=ZSUM4+C*B/YI(I)                                             3110
      SUM5=SUM5+1.0/XA(I)                                               3111
      SUM6=SUM6+1.0/GJ(I)                                               3112
  200 CONTINUE                                                          3113
C                                                                       3114
      PARTC2=YSUM2/(G*S*FNPTS)                                          3115
      B=S/(EM*(4.0*FNPTS**3))                                           3116
      PARTC1=B*ZSUM1                                                    3117
      C1 = PARTC1 + PARTC2                                              3118
      C2=B*ZSUM3+PARTC2                                                 3119
      C3=B*ZSUM4-PARTC2                                                 3120
      C4 = C1*C2 - C3**2                                                3121
      AK(2,2)=C2/C4                                                     3122
      AK(8,2)=C3/C4                                                     3123
      AK(8,8)=C1/C4                                                     3124
      AK(6,6)=(AK(2,2)+2.0*AK(8,2)+AK(8,8))/S**2                        3125
      AK(4,4)=FNPTS*EM/(S*SUM5)                                         3126
      B=S/(EM*(4.0*FNPTS**3))                                           3127
      PARTC1=B*YSUM1                                                    3128
      PARTC2=ZSUM2/(G*S*FNPTS)                                          3129
      C1=PARTC1+PARTC2                                                  3130
      C2=B*YSUM3+PARTC2                                                 3131
      C3=B*YSUM4-PARTC2                                                 3132
      C4=C1*C2-C3**2                                                    3133
C                                                                       3134
      AK(3,3)=C2/C4                                                     3135
      AK(9,3)=C3/C4                                                     3136
      AK(9,9)=C1/C4                                                     3137
      AK(12,2)=(AK(2,2)+AK(8,2))/S                                      3138
      AK(9,5)=(AK(9,3)+AK(9,9))/S                                       3139
      AK(1,1)=FNPTS*G/(S*SUM6)                                          3140
      AK(5,5)=(AK(3,3)+2.0*AK(9,3)+AK(9,9))/S**2                        3141
      AK(8,6)=-(AK(8,2)+AK(8,8))/S                                      3142
      AK(11,9)=-(AK(9,3)+AK(9,9))/S                                     3143
      AK(12,8)=(AK(8,2)+AK(8,8))/S                                      3144
      AK(7,1)=-AK(1,1)                                                  3145
      AK(10,4)=-AK(4,4)                                                 3146
      AK(11,5)=-AK(5,5)                                                 3147
      AK(12,6)=-AK(6,6)                                                 3148
      AK(6,2)=-AK(12,2)                                                 3149
      AK(5,3)=(AK(3,3)+AK(9,3))/S                                       3150
      AK(11,3)=-AK(5,3)                                                 3151
      AK(7,7)=AK(1,1)                                                   3152
      AK(10,10)=AK(4,4)                                                 3153
      AK(11,11)=AK(5,5)                                                 3154
      AK(12,12)=AK(6,6)                                                 3155
C                                                                       3156
      DO 300 I=1,11                                                     3157
      IDIAG=I+1
      DO 300 J=IDIAG,12                                                 3158
  300 AK(I,J)=AK(J,I)                                                   3159
C                                                                       3160
C                                                                       3166
      RETURN                                                            3167
      END                                                               3168
```

SUBROUTINE MAD

```
$IBFTC MAD*    DECK
      SUBROUTINE MAD(A,B)
      DIMENSION A(144),B(144)
      DO 10 I=1,144
      A(I)=A(I)+B(I)
   10 CONTINUE
      RETURN
      END
```

SUBROUTINE SBGS

```
$IBFTC SBGS*    DECK
      SUBROUTINE SBGS(SK,SSK,S,XKG)
      DIMENSION XKG(12,12)
C
C *** COMPUTES STRAIGHT BEAM GEOMETRIC STIFFNESS MATRIX-XKG
C     **CLEAR ARRAY**
      DO 10 I=1,12
      DO 10 J=1,I
      XKG(I,J)=0.0
   10 CONTINUE
C
C     **COMPUTE ELEMENTS OF LOWER TRIANGLE**
      SK= -SK
C
      XKG(6,6)=-1.2/S*SK
      XKG(12,12)=XKG(6,6)
      XKG(12,6)=-XKG(6,6)
      XKG(12,2)=-.1*SK
      XKG(12,8)=XKG(12,2)
      XKG(6,2)=-XKG(12,2)
      XKG(8,6)=XKG(6,2)
      XKG(8,2) =S/30.*SK
      XKG(2,2)=-4.*XKG(8,2)
      XKG(8,8)=XKG(2,2)
C
      SSK=-SSK
      XKG(5,5)=-1.2/S*SSK
      XKG(11,11)=XKG(5,5)
      XKG(11,5)=-XKG(5,5)
      XKG(11,3)=-.1*SSK
      XKG(11,9)=XKG(11,3)
      XKG(5,3)=-XKG(11,3)
      XKG(9,5)=XKG(5,3)
      XKG(9,3)=S/30.*SSK
      XKG(3,3)=-4.*XKG(9,3)
      XKG(9,9)=XKG(3,3)
C     **FILL UPPER TRIANGLE**
C
      DO 20 I=1,11
      IDIAG=I+1
      DO 20 J=IDIAG,12
      XKG(I,J)=XKG(J,I)
   20 CONTINUE
C
      RETURN
      END
```

SUBROUTINE OFST

```
$IBFTC OFST*    DECK
      SUBROUTINE OFST(OFSET,GAMMA,GAM1,GAM2)
C
C     OFFSET BEAM TRANSFORMATION
C
      DIMENSION OFSET(6),GAMMA(12,12),GAM1(6,6),GAM2(6,6)
C
      DO 100 I=1,12
      DO 100 J=1,12
      GAMMA(I,J)=0.0
  100 GAMMA(I,I)=1.0
C
      GAMMA(5,1)=-OFSET(3)
      GAMMA(6,1)=OFSET(2)
      GAMMA(4,2)=OFSET(3)
      GAMMA(6,2)=-OFSET(1)
      GAMMA(4,3)=-OFSET(2)
      GAMMA(5,3)=OFSET(1)
C
      GAMMA(11,7)=-OFSET(6)
      GAMMA(12,7)=OFSET(5)
      GAMMA(10,8)=OFSET(6)
      GAMMA(12,8)=-OFSET(4)
      GAMMA(10,9)=-OFSET(5)
      GAMMA(11,9)=OFSET(4)
C
      DO 500 I=1,6
      DO 500 J=1,6
      GAM1(I,J)=GAMMA(I,J)
  500 GAM2(I,J)=GAMMA(I+6,J+6)
C
      RETURN
      END
```

SUBROUTINE CSTIF

```
$IBFTC CSTIF*  DECK
      SUBROUTINE CSTIF (AK,FLX,SKAB)
C
C     CURVED BEAM STIFFNESS
C
      DIMENSION AK(12,12),FLX(6,6),SKAA(6,6),SKAB(6,6),S(22),
     1TMAB(6,6),TMABT(6,6)
C
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/VAR/NPTS,FNPTS
      COMMON/ADPRO/EM,G,RC,ALFA,DARC,DL
      COMMON/PROPT/YI(100),ZA(100),XA(100),ZI(100),YA(100),GJ(100)
C
      IOUT = MT6
      DO 10 I=1,22
   10 S(I)=0.0
C
      REM=DARC/EM
      RG=DARC/G
      RDE=RC*DARC/EM
      DSIN=SIN(ALFA/FNPTS)
      DCOS=COS(ALFA/FNPTS)
C     FLEXIBILITY MATRIX AT B
C
      DO 40 I=1,NPTS
C
      IF(I.NE.1)GO TO 20
C
      SSIN=SIN(ALFA/(2.0*FNPTS))
      SCOS=COS(ALFA/(2.0*FNPTS))
      GO TO 30
C
   20 SSIN=ESIN*DCOS+ECOS*DSIN
      SCOS=ECOS*DCOS-ESIN*DSIN
C
   30 CONTINUE
      SINSQ=SSIN**2
      COSSQ=SCOS**2
      SICO=SSIN*SCOS
      SCOS1=(1.0-SCOS)
C
      S(1)=S(1)+COSSQ/XA(I)
      S(2)=S(2)+SINSQ/YA(I)
      S(3)=S(3)+SCOS1**2/ZI(I)
      S(4)=S(4)+SICO/XA(I)
      S(5)=S(5)+SICO/YA(I)
      S(6)=S(6)+(SCOS1*SSIN)/ZI(I)
      S(7)=S(7)+SCOS1/ZI(I)
      S(8)=S(8)+SINSQ/XA(I)
      S(9)=S(9)+COSSQ/YA(I)
      S(10)=S(10)+SINSQ/ZI(I)
      S(11)=S(11)+SSIN/ZI(I)
      S(12)=S(12)+1.0/ZA(I)
      S(13)=S(13)+SCOS1**2/GJ(I)
      S(14)=S(14)+SINSQ/YI(I)
      S(15)=S(15)+(SCOS1*SCOS)/GJ(I)
      S(16)=S(16)+(SCOS1*SSIN)/GJ(I)
      S(17)=S(17)+SICO/YI(I)
      S(18)=S(18)+COSSQ/GJ(I)
      S(19)=S(19)+SICO/GJ(I)
      S(20)=S(20)+SINSQ/GJ(I)
      S(21)=S(21)+COSSQ/YI(I)
      S(22)=S(22)+1.0/ZI(I)
C
      ESIN=SSIN
      ECOS=SCOS
C
   40 CONTINUE
C
      DO 50 I=1,6
      DO 50 J=1,6
      FLX(J,I)=0.0
      SKAA(J,I)=0.0
      SKAB(J,I)=0.0
      TMAB(J,I)=0.0
      TMABT(J,I)=0.0
   50 CONTINUE
C
      FLX(1,1)=S(18)*RG+S(14)*REM
      FLX(1,2)=S(19)*RG-S(17)*REM
      FLX(1,6)=-S(15)*RC*RG+S(14)*RDE
      FLX(2,2)=S(20)*RG+S(21)*REM
      FLX(2,6)=-S(16)*RC*RG-S(17)*RDE
      FLX(3,3)=S(22)*REM
      FLX(3,4)=-S(7)*RDE
      FLX(3,5)=S(11)*RDE
      FLX(4,4)=S(1)*REM+S(2)*RG+S(3)*RC*RDE
      FLX(4,5)=S(4)*REM-S(5)*RG-S(6)*RC*RDE
      FLX(5,5)=S(8)*REM+S(9)*RG+S(10)*RC*RDE
      FLX(6,6)=S(12)*RG+S(13)*RC**2*RG+S(14)*RC*RDE
C
      DO 60 I=1,6
      DO 60 J=I,6
   60 FLX(J,I)=FLX(I,J)
C
C     INVERT FLX TO GET STIFFNESS AT B
C
      CALL TINVR(FLX,6,IND)
C
      IF(IGD.NE.0)GO TO 80
      WRITE(IOUT,9000)
 9000 FORMAT(31H1FLEXIBILITY MATRIX IS SINGULAR)
   80 CONTINUE
C
      SSIN=SIN(ALFA)
      SCOS=COS(ALFA)
      TMAB(1,1)=SCOS
      TMAB(1,2)=SSIN
      TMAB(1,6)=-RC*(1.0-SCOS)
      TMAB(2,1)=-SSIN
      TMAB(2,2)=SCOS
      TMAB(2,6)=-RC*SSIN
      TMAB(3,3)=1.0
      TMAB(3,4)=TMAB(1,6)
      TMAB(3,5)=-TMAB(2,6)
      TMAB(4,4)=SCOS
      TMAB(4,5)=SSIN
      TMAB(5,4)=-SSIN
      TMAB(5,5)=SCOS
      TMAB(6,6)=1.0
C
      CALL SMULT(TMAB,FLX,SKAB,6,6,6)
C
      DO 90 I=1,6
      DO 90 J=1,6
   90 TMABT(J,I)=TMAB(I,J)
C
      CALL SMULT(SKAB,TMABT,SKAA,6,6,6)
C
      DO 100 I=1,6
      DO 100 J=1,6
      AK(I,J)=SKAA(I,J)
      AK(I,J+6)=SKAB(I,J)
      AK(I+6,J)=SKAB(J,I)
      AK(I+6,J+6)=FLX(I,J)
  100 CONTINUE
C
      RETURN
      END
```

SUBROUTINE CBMTR

```
$IBFTC CBMTR*  DECK
      SUBROUTINE CBMTR(XI,YI,ZI,XF,YF,ZF,XC,YC,ZC,ALAMA,ALAMB,CLAM)
C
C     CURVE BEAM TRANSFORMATION MATRIX
C
C
      DIMENSION ALAM(3,3),ALAMA(6,6),ALAMB(6,6),CLAM(12,12),
     1RCP(3,3),RCN(3,3), RCF(3,3)
C
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/VAR/NPTS,FNPTS
      COMMON/ADPRO/EM,G,RC,ALFA,DARC,DL
      COMMON/LTRAN/L1,M1,N1,L2,M2,N2,L3,M3,N3
      REAL L1,M1,N1,L2,M2,N2,L3,M3,N3
C
      IOUT = MT6
      XFI=XF-XI
      YFI=YF-YI
      ZFI=ZF-ZI
      XCI=XC-XI
      YCI=YC-YI
      ZCI=ZC-ZI
      DS=SQRT(XFI**2+YFI**2)
      DL=SQRT(XFI**2+YFI**2+ZFI**2)
      F=(XCI*XFI+YCI*YFI)/DS
      B=-(XCI*YFI-YCI*XFI)/DS
      D=(-F*ZFI+ZCI*DS)/DL
      DIV=SQRT(D*D+B*B)
      DIVR=SQRT(XCI**2+YCI**2)
C
      DO 5  I=1,3
      DO 5  J=1,3
   10 ALAM(I,J)=0.0
      RCN(I,J)=0.0
    5 RCP(I,J)=0.0
C
      RCN(1,1)=1.0
      RCN(2,3)=1.0
      RCN(3,2)=-1.0
C
      RCP(1,1)=1.0
      RCP(2,3)=-1.0
      RCP(3,2)=1.0
C
C
      IF(DS)20,40,60
C
   20 WRITE(IOUT,9000)XI,YI,ZI,XF,YF,ZF
 9000 FORMAT(19H1LENGTH IS NEGATIVE///(6E10.3))
C
   40 CONTINUE
      SINB=YCI/DIVR
      COSB=XCI/DIVR
      ALAM(1,3)=ZFI/DL
      ALAM(2,1)=SINB*(ZFI/DL)
      ALAM(2,2)=COSB*(ZFI/DL)
      ALAM(3,1)=COSB
      ALAM(3,2)=SINB
      GO TO 65
C
   60 CONTINUE
      COSB=D/DIV
      SINB=B/DIV
      ALAM(1,1)=XFI/DL
      ALAM(1,2)=YFI/DL
      ALAM(1,3)=ZFI/DL
      ALAM(2,1)=-COSB*(YFI/DS)+SINB*(ZFI/DL)*(XFI/DS)
      ALAM(2,2)=COSB*(XFI/DS)+SINB*(ZFI/DL)*(YFI/DS)
      ALAM(2,3)=-SINB*(DS/DL)
      ALAM(3,1)=-SINB*(YFI/DS)-COSB*(ZFI/DL)*(XFI/DS)
      ALAM(3,2)=SINB*(XFI/DS)-COSB*(ZFI/DL)*(YFI/DS)
      ALAM(3,3)=COSB*(DS/DL)
C
   65 CONTINUE
C
      IF(RC.LT.0.0)GO TO 80
      CALL MULT (RCP,ALAM,RCF,3,3,3,1,0)
      GO TO 85
   80 CALL MULT(RCN,ALAM,RCF,3,3,3,1,0)
   85 CONTINUE
C
      L1=RCF(1,1)
      L2=RCF(2,1)
      L3=RCF(3,1)
      M1=RCF(1,2)
      M2=RCF(2,2)
      M3=RCF(3,2)
      N1=RCF(1,3)
      N2=RCF(2,3)
      N3=RCF(3,3)
C
      DO 110 I=1,6
      DO 110 J=1,6
      ALAMA(I,J)=0.0
  110 ALAMB(I,J)=0.0
C
      DO 115 I=1,12
      DO 115 J=1,12
  115 CLAM(I,J)=0.0
C
      RC=ABS(RC)
      ALFA = DL/(2.0*RC)
      ALFA=ASIN(ALFA)
      CALFA=COS(ALFA)
      SALFA=SIN(ALFA)
      DARC=2.0*(RC*ALFA/FNPTS)
      DL=DARC*FNPTS
      ALFA=2.0*ALFA
C
C
      ALAMA(1,1)=L1*CALFA+L2*SALFA
      ALAMA(1,2)=M1*CALFA+M2*SALFA
      ALAMA(1,3)=N1*CALFA+N2*SALFA
      ALAMA(2,1)=-L1*SALFA+L2*CALFA
      ALAMA(2,2)=-M1*SALFA+M2*CALFA
      ALAMA(2,3)=-N1*SALFA+N2*CALFA
      ALAMA(3,1)=L3
      ALAMA(3,2)=M3
      ALAMA(3,3)=N3
C
      ALAMB(1,1)=L1*CALFA-L2*SALFA
      ALAMB(1,2)=M1*CALFA-M2*SALFA
      ALAMB(1,3)=N1*CALFA-N2*SALFA
      ALAMB(2,1)=L1*SALFA+L2*CALFA
      ALAMB(2,2)=M1*SALFA+M2*CALFA
      ALAMB(2,3)=N1*SALFA+N2*CALFA
      ALAMB(3,1)=L3
      ALAMB(3,2)=M3
      ALAMB(3,3)=N3
C
      DO 120 I=1,3
      DO 120 J=1,3
      ALAMA(I+3,J+3)=ALAMA(I,J)
      ALAMB(I+3,J+3)=ALAMB(I,J)
  120 CONTINUE
C
      DO 130 I=1,6
      DO 130 J=1,6
      CLAM(I,J)=ALAMA(I,J)
      CLAM(I+6,J+6)=ALAMB(I,J)
  130 CONTINUE
C
      RETURN
      END
```

SUBROUTINE MERGE

```
$IBFTC MERGE*  DECK
      SUBROUTINE MERGE
C     CONTROL SECTION FOR MERGE AND BOUNDARY
      COMMON/CONT1/JPART(800)
      COMMON/CONT2/KPART(800)
      COMMON/CONT3/LPART(800)
      COMMON/LASTND/LN(200)
      COMMON/CONTRL/NDEFL,NKSP,NREX,NNF,NPSTR,NBSTR,NVIB
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP,NOPT(4)
      COMMON/COMS/NSIZE(200)
      COMMON/SKIP/NBSP,NBSB,NBSPI,NBSBI
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/REDUC/NTEST,NTEST2
C
C
      IOUT = MT6
      ISTIF = MT2
      IKBC = MT3
      IKDF = MT4
      KFF = MT11
      KSTRES = MT8
C
C     SPACING FOR TAPES LOGIC 2 AND LOGIC 15
C     NBSP=NUMBER OF LOGICAL RECORDS FOR PLATE STRESS
      NBSP=NPLATE*8
C     NBSPI=NUMBER OF LOGICAL RECORDS FOR PLATE INTERNAL LOADS
      NBSPI=NPLATE*2
C     NBSB=NUMBER OF LOGICAL RECORDS FOR BEAM STRESS
      NBSB=NBEAM*4
C     NBSBI=NUMBER OF LOGICAL RECORDS FOR BEAM INTERNAL LOADS
      NBSBI=NBEAM*3
C
      REWIND ISTIF
      REWIND IKBC
      REWIND IKDF
      REWIND KFF
      REWIND KSTRES
C
      CALL SOR (JPART,KPART,LPART,800)
C
C
      CALL MERGBC
      IF (NOPT(3) .NE. NTEST2) CALL STRESS
C
      REWIND ISTIF
      REWIND IKBC
      REWIND IKDF
      REWIND KFF
      REWIND KSTRES
C
 1000 RETURN
      END
```

SUBROUTINE SOR

```
$IBFTC SOR*    DECK
      SUBROUTINE SOR (JPART,KPART,LPART,NPS)
C
C     SORTS THE CONNECTIVITY DATA SO THAT JPART
C     ARRAY STARTS WITH THE FIRST PARTITION
C     AND GOES THRU EVERY ROW OF PARTITIONS
C     CONSECUTIVELY***1001,2001,2002,3001,ETC.***
C
      DIMENSION JPART(1),KPART(1),LPART(1)
      NPS1=NPS-1
      DO 40 I=1,NPS1
      IF(JPART(I).EQ.0)GO TO 40
      MIN=JPART(I)
      K=I
      DO 20 M=I,NPS1
      IF(JPART(M+1).EQ.0)GO TO 20
      IF(MIN.LT.JPART(M+1))GO TO 20
      MIN=JPART(M+1)
      K=M+1
   20 CONTINUE
      JPART(K)=JPART(I)
      JPART(I)=MIN
      MIN1=KPART(K)
      KPART(K)=KPART(I)
      KPART(I)=MIN1
      MIN2=LPART(K)
      LPART(K)= LPART(I)
      LPART(I)=MIN2
      K=I +1
   40 CONTINUE
      RETURN
      END
```

SUBROUTINE MERGBC

```
$IBFTC MERGB*  DECK
      SUBROUTINE MERGBC
C
C     MERGE AND BOUNDARY OF STIFFNESS
C
      COMMON/CONT1/JPART(800)
      COMMON/CONT2/KPART(800)
      COMMON/CONT3/LPART(800)
      COMMON/COMS/NSIZE(200)
      COMMON/LASTND/LN(200)
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP
      COMMON/CONTRL/NDEFL,NKSP,NREX,NNF,NPSTR,NBSTR,NVIB,IF88
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
C
      DIMENSION TEMP(  60),ID(60),SPRING(60),
     1NNI1(3),NNJ1(3),NDIAG(3)
     2,FKK(6),JKK(6),IDD(60),MNN(4)
      DIMENSION NT(3),NB(3),NR(3),NL(3),ELEM(60,60,3),A(6,6,4),
     1B(6,6,16),JPAR(3),KPAR(3),LPAR(3),ICODE(200,10)
      DIMENSION ARRAYB(144),ARRAYP(576),IDRRY(12)
      EQUIVALENCE(ARRAYB,A),(ARRAYP,B)
C
C     0  FREE
C     1  ZERO DEFLECTION
C     2  SPECIFIED DEFLECTION
C     3  SPRUNG
C
C     NVIB IS A PRINT OPTION
      INTEGER QZ,QP
      LOGICAL NFIND,NSPR
C
      IOUT = MT6
      QP = MT8
      QZ = MT2
      KFF = MT11
      IKBC = MT3
      REWIND QP
      REWIND QZ
      REWIND KFF
      REWIND IKBC
      PRINT 6969
C
      ZERO=0.0
      DO 2 I=1,200
    2 NSIZE(I)=0
C
      IDI=0
      NPM=0
      IMK=0
      L1=1
      L2=2
      L3=3
C
C
    4 CONTINUE
C
```

```
C
C      WORK WITH THREE PARTITIONS
C****** DETERMINE FIRST AND LAST BEAMS AND PLATES IN THIS SET.
      JPAR(1)=JPART(L1)
      JPAR(2)=JPART(L2)
      JPAR(3)=JPART(L3)
C****** KPART(K)=I00J MEANS THE I-TH BEAM IS THE FIRST
C****** BEAM CONNECTED TO A NODE IN THE K-TH PARTITION,
C****** AND THE J-TH BEAM IS THE LAST BEAM IN THE K-TH
C****** PARTITION. LPART IS A SIMILAR ARRAY FOR PLATES.
      KMIN=KPART(L1)/10000
      LMIN=LPART(L1)/10000
      KMAX=KPART(L1)-10000*KMIN
      LMAX=LPART(L1)-10000*LMIN
      DO 20 I=L2,L3
      KF=KPART(I)/10000
      KL=KPART(I)-10000*KF
      LF=LPART(I)/10000
      LL=LPART(I)-10000*LF
      IF(KL.GT.KMAX)KMAX=KL
      IF(LL.GT.LMAX)LMAX=LL
      IF((KF.NE.0).AND.(KF.LT.KMIN))KMIN=KF
      IF((LF.NE.0).AND.(LF.LT.LMIN))LMIN=LF
      IF(KMIN.EQ.0)KMIN=KF
      IF(LMIN.EQ.0)LMIN=LF
   20 CONTINUE
C
C****** ZERO OUT AND SIZE THE THREE PARTITIONS                          MERGBC
      DO 8 K=1,3
C
      NI=JPAR (K)/1000
      NJ=JPAR (K)-NI*1000
      NNI1(K)=NI
      NNJ1(K)=NJ
      IF(NI.NE.0)GO TO 7
      NB(K)=0
      NT(K)=0
      NR(K)=0
      NL(K)=0
      GO TO 9
    7 CONTINUE
      IF(NI.NE.1)NT(K)=LN(NI-1)+1
      IF(NI.EQ.1)NT(K)=1
      NB(K)=LN(NI)
      IF(NJ.NE.1)NL(K)=LN(NJ-1)+1
      IF(NJ.EQ.1)NL(K)=1
      NR(K)=LN(NJ)
      NRL=(NR(K)-NL(K)+1)*6
      NBT=(NB(K)-NT(K)+1)*6
      DO 8 J=1,NRL
      DO 8 M=1,NBT
      ELEM(M,J,K)=0.
    8 CONTINUE
    9 CONTINUE
C
      IF(NVIB.NE.1)GO TO 8100
      WRITE(IOUT,9600)(NT(K),NB(K),NR(K),NL(K),K=1,3)
 8100 CONTINUE
C
C
```

```
      IF(NBEAM.EQ.0)GO TO 1004
C
C
C****** SPACE TO FIRST BEAM IN THIS SET OF PARTITIONS
      KB=0
      IF(KMIN-1)1004,22,23
   23 KMIN1=(KMIN-1)*2
      DO 21 ISPA=1,KMIN1
      KB=KB+1
   21 READ(QZ)DUMMY
      KB=KB/2
   22 CONTINUE
      PRINT 6971,(JPAR(IMT),IMT=1,3),KMIN,KMAX
C     READING BEAM STIFFNESS
   15 READ(QZ)N1,N2
      NFIND=.FALSE.
      KB=KB+1
C
C****** TEST ALL COMBINATIONS OF NODES
      DO 1000 I=1,4
      GO TO(100,200,300,400),I
  100 M1=N1
      M2=N1
      GO TO 500
  200 M1=N1
      M2=N2
      GO TO 500
  300 M1=N2
      M2=N1
      GO TO 500
  400 M1=N2
      M2=N2
  500 CONTINUE
C
      DO 800 L=1,3
      IF((M1.GT.NB(L)).OR.(M1.LT.NT(L))) GO TO 800
      IF((M2.GT.NR(L)).OR.(M2.LT.NL(L))) GO TO 800
C
C****** READ STIFFNESS, IF NECESSARY
      IF(NFIND) GO TO 501
      NFIND=.TRUE.
      READ(QZ)(ARRAYB(MJ),MJ=1,144)
  501 CONTINUE
C     ADDING IN BEAM STIFFNESSES
      DO 700 N=1,6
      KROW=(M1-NT(L))*6+N
      DO 700 M=1,6
      KCOL=(M2-NL(L))*6+M
  700 ELEM(KROW,KCOL,L)=ELEM(KROW,KCOL,L)+A(N,M,I)
      GO TO 1000
  800 CONTINUE
C
 1000 CONTINUE
      IF(.NOT.NFIND) READ(QZ)DUMMY
C
C****** LOOP FOR ALL BEAMS IN THIS SET
      IF(KB.LT.KMAX)GO TO 15
C
      REWIND QZ
C
```

```
 1004 CONTINUE
      IF(NPLATE.EQ.0)GO TO 4000
C
C
C****** SPACE DOWN TAPE TO FIRST PLATE IN THIS SET.
      NQ=0
      IF(LMIN-1)4000,25,24
   24 LMIN1=(LMIN-1)*2
      DO 26 ISPA=1,LMIN1
      NQ=NQ+1
   26 READ(QP)DUMMY
      NQ=NQ/2
   25 CONTINUE
      PRINT 6972,LMIN,LMAX
C     READING PLATE STIFFNESS
 1005 READ(QP)(MNN(I),I=1,4)
C****** TEST ALL COMBINATIONS OF NODES.
      NFIND=.FALSE.
      NQ=NQ+1
C
      MLT=4
      IF(MNN(4).EQ.0)MLT=3
C
      DO 2900 I=1,MLT
      M1=MNN(I)
      DO 2900 J=1,MLT
      M2=MNN(J)
C
      DO 2800 L=1,3
      IF((M1.GT.NB(L)).OR.(M1.LT.NT(L)))GO TO 2800
      IF((M2.GT.NR(L)).OR.(M2.LT.NL(L))) GO TO 2800
C****** READ PLATE STIFFNESS, IF NECESSARY.
      IF(NFIND) GO TO 2901
      NFIND=.TRUE.
      READ(QP) (ARRAYP(MJ),MJ=1,576)
 2901 CONTINUE
C
C     ADDING IN PLATE STIFFNESSES
      DO 2700 N=1,6
      KROW=(M1-NT(L))*6+N
      DO 2700 M=1,6
      KCOL=(M2-NL(L))*6+M
      NII=4*(I-1)+J
 2700 ELEM(KROW,KCOL,L)=ELEM(KROW,KCOL,L)+B(N,M,NII)
      GO TO 2900
 2800 CONTINUE
C
 2900 CONTINUE
      IF(.NOT.NFIND) READ (QP) DUMMY
C
C****** LOOP FOR ALL PLATES IN THIS SET.
      IF(NQ.LT.LMAX) GO TO 1005
C
      REWIND QP
C
 4000 CONTINUE
C
C
C
      PRINT 6973
```

```
C      BOUNDARY CONDITIONS
C
C
C
C****** LOOP FOR 3 PARTITIONS.
       DO 7300 N=1,3
C
       IF(JPAR(N).EQ.0) GO TO 7300
       NDIAG(N)=0
       NUNC=0
       NUNR=0
       NBOT=NB(N)-NT(N)+1
       NBOTF=NBOT*6
       NBOTF1=NBOTF-1
       NRL=NR(N)-NL(N)+1
       NRLF=NRL*6
       NRLF1=NRLF-1
       IF(IMK.EQ.NNI1(N))GO TO 7008
       K=1
       NI=NNI1(N)
C
       DO 7007 I=1,NBOT
       READ(IKBC)M,IJKLMN
       CALL UNPACK(IJKLMN,JKK(1),JKK(2),JKK(3),JKK(4),JKK(5),JKK(6))
       ICODE(NI,I)=IJKLMN
       NSPR = .FALSE.
       DO 7005 L=1,6
       IF(JKK(L).NE.3) GO TO 7005
       NSPR = .TRUE.
       READ(IKBC)(FKK(JJ),JJ=1,6)
       GO TO 7006
 7005  CONTINUE
 7006  CONTINUE
       DO 107 L=1,6
       M=L+K-1
       IF (.NOT.NSPR) GO TO 107
       SPRING(M)=FKK(L)
  107  ID(M)=JKK(L)
       K=K+6
 7007  CONTINUE
C
C
 7008  CONTINUE
C
       DO 7009 L=1,60
 7009  IDD(L)=ID(L)
C****** NDIAG(N)=1, IF THE N-TH PARTITION IN THIS SET
C****** IS A DIAGONAL ONE.
C
       IF(NNI1(N).EQ.NNJ1(N))NDIAG (N)=1
       IK=0
       IFIX=0
       DO 7010 I=1,NBOTF
       IF((ID(I).EQ.1).OR.(ID(I).EQ.2))IK=IK+1
 7010  CONTINUE
       IF(IK.EQ.NBOTF)IFIX=1
       IF(NDIAG(N).NE.1)GO TO 7030
       IDI=IDI+1
       NSIZE(IDI)=NBOTF-IK
       IF(.NOT. NSPR) GO TO 7030
```

```
C     ADD SPRING CONSTANTS TO DIAGONAL TERMS
      DO 7025 I=1,NBOTF
      IF(ID(I).NE.3)GO TO 7025
      ELEM(I,I,N)=ELEM(I,I,N)+SPRING(I)
 7025 CONTINUE
 7030 CONTINUE
C
C****** SORT CONSTRAINED ELEMENTS TO BOTTOM.
      DO 7035 I=1,NBOTF
      II=NBOTF-I+1
      IF((ID(II).EQ.1).OR.(ID(II).EQ.2))GO TO 7038
 7035 CONTINUE
 7038 ILAST=II
      JJJ=0
C
C
      DO 7150 I=1,ILAST
C
      IJK=0
      IF((ID(I).NE.1).AND.(ID(I).NE.2))GO TO 7150
      IJK=1
      IF(JJJ.EQ.0)IJK=0
      JJJ=JJJ+1
      KK=I-JJJ+1
      NUNR=NUNR+1
      IF(NDIAG(N).NE.1)GO TO 7044
      NUNC=NUNR
      GO TO 7050
 7044 CONTINUE
      ITR=NNJ1(N)
      NUN1=NSIZE(ITR)
      NUNC=NRLF-NUN1
 7050 CONTINUE
C
      DO 7060 L=1,NRLF
      TEMP(L)=ELEM(KK,L,N)
 7060 CONTINUE
C
      DO 7080 K=KK,NBOTF1
      DO 7080 M=1,NRLF
      ELEM(K,M,N)=ELEM(K+1,M,N)
 7080 CONTINUE
C
C****** SORT CONSTRAINED ELEMENTS TO RIGHT.
      DO 7090 II=1,NRLF
      ELEM(NBOTF,II,N)=TEMP(II)
 7090 CONTINUE
 7150 CONTINUE
C
      NJ=NNJ1(N)
      K=1
      DO 108 I=1,NRL
      CALL UNPACK(ICODE(NJ,I),ID(K),ID(K+1),ID(K+2),ID(K+3),ID(K+4),
     1 ID(K+5))
  108 K=K+6
      DO 101 I=1,NRLF
      ILAST=NRLF-I+1
      IF((ID(ILAST).EQ.1).OR.(ID(ILAST).EQ.2)) GO TO 102
  101 CONTINUE
  102 JJJ=0
```

```
      DO 103 I=1,ILAST
      IF((ID(I).NE.1).AND.(ID(I).NE.2)) GO TO 103
      JJJ=JJJ+1
      KK=I-JJJ+1
      DO 104 L=1,NBOTF
  104 TEMP(L)=ELEM(L,KK,N)
      DO 105 K=KK,NRLF1
      DO 105 M=1,NBOTF
  105 ELEM(M,K,N)=ELEM(M,K+1,N)
      DO 106 L=1,NBOTF
  106 ELEM(L,NRLF,N)=TEMP(L)
  103 CONTINUE
C
      IF((IK.NE.0).OR.(NDIAG(N).EQ.1))GO TO 7155
      ITR=NNJ1(N)
      NUN1=NSIZE(ITR)
      NUNC=NRLF-NUN1
 7155 CONTINUE
      IF((IFIX.NE.1).OR.(NDIAG(N).EQ.1))GO TO 7165
      ITR=NNJ1(N)
      NUN1=NSIZE(ITR)
      NUNC=NRLF-NUN1
 7165 CONTINUE
C
C
      NROW=NBOTF-NUNR
      NCOL=NRLF-NUNC
      NBR=NROW+1
      NBC=NCOL+1
C
C
C****** WRITE STIFFNESS PARTITIONS ON TAPE.
      IF((IK.EQ.0).AND.(NDIAG(N).EQ.1))GO TO 7280
      IF((IK.EQ.0).AND.(NDIAG(N).NE.1))GO TO 7168
      IF((IFIX.NE.1).OR.(NDIAG(N).NE.1))GO TO 7162
C
      K8=JPAR(N)+1000000
      K8COL=NRLF
      K8ROW=NBOTF
 8200 CONTINUE
      GO TO 7296
C
 7162 CONTINUE
      IF((IFIX.NE.1).OR.(NDIAG(N).EQ.1))GO TO 7164
      ITR=NNJ1(N)
      NUN1=NSIZE(ITR)
      IF(NUN1 .NE. NRLF) GO TO 7163
      K8=JPAR(N)+2000000
      K8COL=NRLF
      K8ROW=NBOTF
 8300 CONTINUE
      GO TO 7296
 7163 CONTINUE
 7164 CONTINUE
C
      IF(NBC.GT.NRLF) GO TO 8400
      K88=K88+1
      K8=JPAR(N)+1000000
      K8ROW=NBOTF-NBR+1
      K8COL=NRLF-NBC+1
 8400 CONTINUE
      IF(NCOL.EQ.0)GO TO 8500
      K8=JPAR(N)+2000000
      K8COL=NCOL
      K8ROW=NBOTF-NBR+1
 8500 CONTINUE
      IF((IFIX.EQ.1).AND.(NDIAG(N).NE.1))GO TO 7296
C
 7168 CONTINUE
      IF(NNI1(N).EQ.NNJ1(N))GO TO 7200
      IF((IK.NE.0).OR.(NDIAG(N).EQ.1))GO TO 7178
      ITR=NNJ1(N)
      NUN1=NSIZE(ITR)
      IF(NUN1.NE.NRLF)GO TO 7176
      CALL WRTETP(ELEM(1,1,N),60,JPAR(N),NBOTF,NRLF,IDRRY,0,0,KFF,IRROR)
      K8=JPAR(N)+4000000
      K8COL=NRLF
      K8ROW=NBOTF
      IF(NVIB.NE.1)GO TO 8600
      CALL PRINT(ELEM(1,1,N),K8ROW,K8COL,1,5HSTIFF,0,60)
 8600 CONTINUE
      GO TO 7296
 7176 CONTINUE
C
 7178 CONTINUE
      IF(NBC.GT.NRLF) GO TO 8700
      IFPAR=NNJ1(N)*1000+NNI1(N)
C     KCF TERM FOR OFF DIAGONAL PARTITION
      K8=JPAR(N)+3000000
      K8COL=NRLF-NBC+1
      K8ROW=NROW
 8700 CONTINUE
 7200 CONTINUE
C
 7280 CONTINUE
      IF(NCOL.EQ.0)GO TO 8800
      CALL WRTETP(ELEM(1,1,N),60,JPAR(N),NROW,NCOL,IDARRY,0,0,KFF,IRROR)
      K8=JPAR(N)+4000000
      K8COL=NCOL
      K8ROW=NROW
      IF(NVIB.NE.1)GO TO 8800
      CALL PRINT(ELEM(1,1,N),K8ROW,K8COL,1,5HSTIFF,0,60)
 8800 CONTINUE
C
 7296 CONTINUE
C
      DO 7298 L=1,60
 7298 ID(L)=IDD(L)
      IMK=NNI1(N)
C
C
C
 7300 CONTINUE
C
C
C
      NPM=NPM+3
      L1=L1+3
      L2=L2+3
      L3=L3+3
```

```
C                                                                       4484
C     TEST FOR TOTAL NUMBER OF PARITIONS                                4485
      PRINT 6974                                                        4486
      IF(NPM.LT.NTOL)GO TO 4                                            4487
      REWIND KFF                                                        4489
      REWIND IKBC                                                       4492
C****** CONVERT KPART AND LPART ARRAYS TO FORM COMPATIBLE WITH
C****** SUBROUTINE MFORCE.
      DO 30 I=1,NTOL                                                    4496
      KPART(I)=KPART(I)-(KPART(I)/10000)*10000                          4497
   30 LPART(I)=LPART(I)-(LPART(I)/10000)*10000                          4498
      PRINT 6970                                                        4499
C                                                                       4500
 9001 FORMAT(16H JR88 IDENT NO. I6,10X,I2,4H BY I2)
 9600 FORMAT(24H1NT     NB     NR     NL///(4I8))                       4507
 6969 FORMAT(1H ,11HBEGIN MERGE)                                        4508
 6970 FORMAT(1H ,09HEND MERGE)                                          4509
 6971 FORMAT(1H ,7HJPAR = ,3(I6,1H,),7HKMIN = ,I6,7HKMAX = ,I6)         4510
 6972 FORMAT(1H ,7HLMIN = ,I6,7HLMAX = ,I6)                             4511
 6973 FORMAT(1H ,8HSTART BC)                                            4512
 6974 FORMAT(1H ,6HEND BC)                                              4513
C                                                                       4514
 7400 RETURN                                                            4515
      END                                                               4516
```

SUBROUTINE STRESS

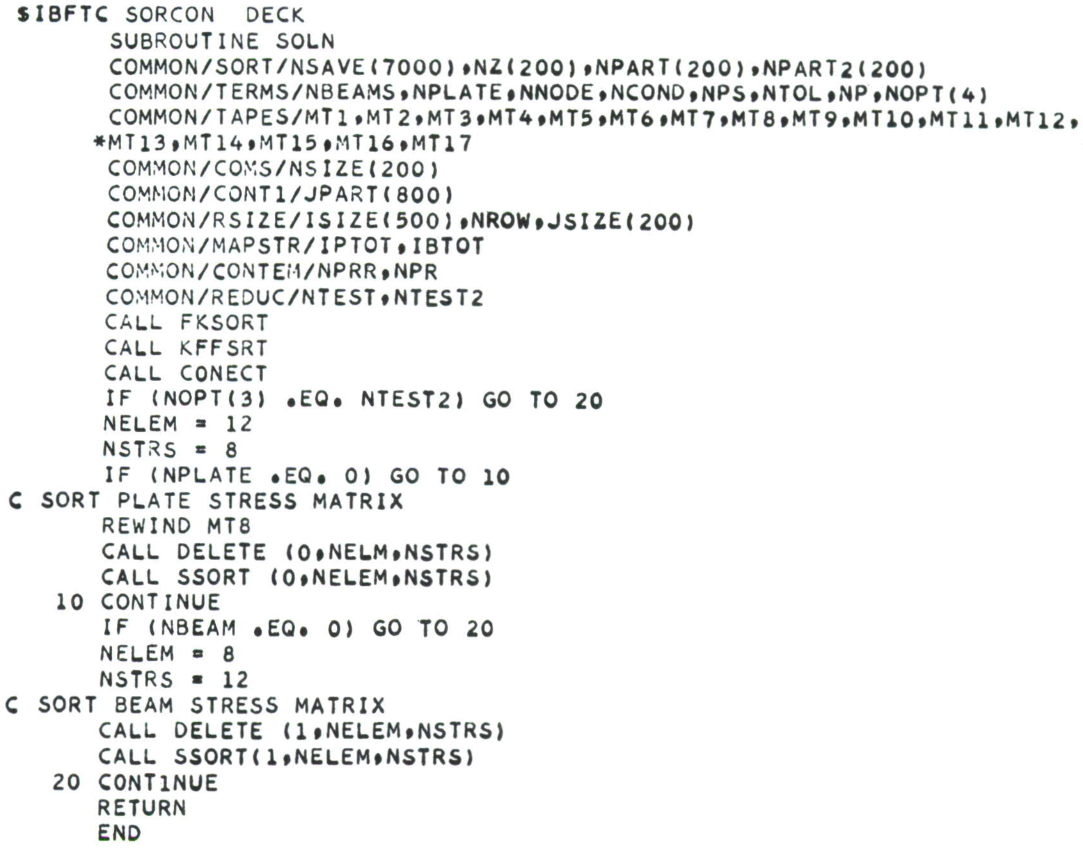
```
$IBFTC STRES*  DECK
      SUBROUTINE STRESS
C
C     CONTROL SECTION FOR STRESS CALCULATIONS
C
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP
      COMMON/CONTRL/NDEFL,NKSP,NREX,NNF,NPSTR,NBSTR,NVIB
      COMMON/SKIP/NBSP,NBSB,NBSPI,NBSBI
      COMMON/PBSIZE/IPB,IPBL,IPBN,NELEM,NOD
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/LOADS/BIG1(96,60)
C
C     LIST OF ARGUMENTS FOR PLATES AND BEAM MERGER
C
C     NELEM=   NPLATE      NBEAM
C
      IOUT = MT6
      ISTRS = MT16
      REWIND ISTRS
      IF(NPLATE .EQ. 0) GO TO 10
C
      IPB = 12
      IPBL = 96
      IPBN=8
      NELEM=NPLATE
      NOD=4
      PRINT 91
      PRINT 92
      CALL MSTRES
   10 CONTINUE
C
      IF(NBEAM .EQ. 0) GO TO 20
C
      IPB = 8
      IPBL = 96
      IPBN=12
      NELEM=NBEAM
      NOD=2
C
      PRINT 93
      PRINT 94
      CALL MSTRES
   20 CONTINUE
C
      RETURN
   91 FORMAT(12H CALL IPLATE)
   92 FORMAT(12H CALL PSTRES)
   93 FORMAT(12H CALL  IBEAM)
   94 FORMAT(12H CALL BSTRES)
      END
```

SUBROUTINE MSTRES

```
$IBFTC MSTRE*  DECK
      SUBROUTINE MSTRES
      COMMON/CONTRL/NDEFL,NKSP,NREX,NNF,NPSTR,NBSTR,NVIB                5195
      COMMON/LASTND/LN(200)                                             5196
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP                 5197
      COMMON/SKIP/NBSP,NBSB,NBSPI,NBSBI                                 5198
      COMMON/PBSIZE/IPB,IPBL,IPBN,NELEM,NOD
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/MAPSTR/IPTOT,IBTOT
C     NOD=2 FOR BEAMS,    4 FOR PLATES.
      DIMENSION BIG(96,60),A(68,8,6),NN(68)
      EQUIVALENCE(A,B)
      DIMENSION B(22,12,6)
      COMMON/LOADS/BIG
      LOGICAL LAST


      IOUT = MT6
      ISTRS = MT16
      KSTRES = MT8
C     INITIALIZE
      NTOT = 0
      IF((NPLATE.EQ.0).OR.(NPSTR.NE.0)) GO TO 11
      DO 10 I=1,NBSPI
   10 READ(ISTRS) NDUM
   11 CONTINUE
      NTIM=NELEM/IPB
      NTIML=NELEM-NTIM*IPB
      NLIM=NTIM
      IF(NTIML.NE.0)NLIM=NLIM+1
      LAST=.FALSE.
C      LOOP FOR SETS OF ELEMENTS
      DO 2000 LPL=1,NLIM
      IF(LPL.GT.NTIM) LAST=.TRUE.
 2001 MLIM=IPB
      IF(LAST)MLIM=NTIML
C      READ IN STRESSES
      DO 3100 K=1,MLIM
      KN1=K+MLIM
      KN2=KN1+MLIM
      KN3=KN2+MLIM
      IF(NOD.EQ.2) GO TO 2002
      READ(ISTRS) NB    ,NN(K),NN(KN1),NN(KN2),NN(KN3)
      READ(ISTRS)((A(K,I,J),I=1,IPBN),J=1,6),((A(KN1,I,J),I=1,IPBN),J=1
     11,6),((A(KN2,I,J),I=1,IPBN),J=1,6),((A(KN3,I,J),I=1,IPBN),J=1,6)
      GO TO 3100
 2002 READ(ISTRS) NB    ,NN(K),NN(KN1)
      READ(ISTRS) ((B(K,I,J),I=1,IPBN),J=1,6),((B(KN1,I,J),I=1,IPBN),J=1
     1 ,6)
 3100 CONTINUE
      LLIM=KN3
      IF(NOD.EQ.2) LLIM=KN1
C       LOOP FOR PARTITIONS
      DO 4100 K=1,NPS                                                   5306
      IRITE=0                                                           5307
      DO 300 I=1,IPBL
      DO 300 J=1,60
  300 BIG(I,J)=0.0
      DO 3800 L=1,LLIM
C        CHECK TO SEE IF NODE IS IN THIS PARTITION
      IF(K.NE.1)GO TO 3450
      IF(NN(L).EQ.0) GO TO 3800
      IF(NN(L).GT.LN(1))GO TO 3800
      GO TO 3400
 3450 CONTINUE
      IF((NN(L).GT.LN(K)).OR. (NN(L).LE.LN(K-1)))GO TO 3800
 3400 CONTINUE
      IRITE=1
C
C        ADD IN STRESSES
      DO 3700 N=1,IPBN
      L1=L-1
      KROW=(MOD(L1,MLIM))*IPBN+N
      DO 3700 M=1,6
      IF(K.NE.1)GO TO 3460
      KCOL=(NN(L)-1)*6+M
      GO TO 3480
 3460 CONTINUE
      KCOL=(NN(L)-LN(K-1)-1)*6+M
 3480 CONTINUE
      IF(NOD.EQ.4) GO TO 3701
      BIG(KROW,KCOL)=B(L,N,M)
      GO TO 3700
 3701 BIG(KROW,KCOL)=A(L,N,M)
 3700 CONTINUE
      NN(L)=0
 3800 CONTINUE
C
      IF(IRITE.NE.1)GO TO 4000
      NTOT=NTOT+1
C        WRITE STRESS PARTITION ON TAPE
      MAP=1000*LPL+K
      WRITE(KSTRES)MAP
      NSIZE=LN(1)*6
      IF(K.GT.1)NSIZE=(LN(K)-LN(K-1))*6
      KNN=IPBL
      IF(LAST)KNN=IPBN*NTIML
      WRITE(KSTRES)((BIG(I,J),I=1,KNN),J=1,NSIZE)
      IF(NVIB.NE.1)GO TO 3900
      IF(NOD.EQ.2) WRITE(IOUT,9001) MAP
      IF(NOD.EQ.4)WRITE(IOUT,9002)  MAP
      CALL PRINT(BIG,KNN,NSIZE,1,4H BIG,1,48)
 3900 CONTINUE
 4000 CONTINUE
C
 4100 CONTINUE
C
 2000 CONTINUE
      IF(NOD.EQ.2) GO TO 5000
      IPTOT=NTOT
      GO TO 5001
 5000 IBTOT=NTOT
 9001 FORMAT(22H MERGED BEAM STRESSES,I8,15HWRITTEN ON TAPE)
 9002 FORMAT(23H MERGED PLATE STRESSES,I8,15HWRITTEN ON TAPE)
 5001 RETURN
      END
```

SUBROUTINE SOLN



```
$IBFTC SORCON  DECK
      SUBROUTINE SOLN
      COMMON/SORT/NSAVE(7000),NZ(200),NPART(200),NPART2(200)
      COMMON/TERMS/NBEAMS,NPLATE,NNODE,NCOND,NPS,NTOL,NP,NOPT(4)
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     *MT13,MT14,MT15,MT16,MT17
      COMMON/COMS/NSIZE(200)
      COMMON/CONT1/JPART(800)
      COMMON/RSIZE/ISIZE(500),NROW,JSIZE(200)
      COMMON/MAPSTR/IPTOT,IBTOT
      COMMON/CONTEM/NPRR,NPR
      COMMON/REDUC/NTEST,NTEST2
      CALL FKSORT
      CALL KFFSRT
      CALL CONECT
      IF (NOPT(3) .EQ. NTEST2) GO TO 20
      NELEM = 12
      NSTRS = 8
      IF (NPLATE .EQ. 0) GO TO 10
C SORT PLATE STRESS MATRIX
      REWIND MT8
      CALL DELETE (0,NELM,NSTRS)
      CALL SSORT (0,NELEM,NSTRS)
   10 CONTINUE
      IF (NBEAM .EQ. 0) GO TO 20
      NELEM = 8
      NSTRS = 12
C SORT BEAM STRESS MATRIX
      CALL DELETE (1,NELEM,NSTRS)
      CALL SSORT(1,NELEM,NSTRS)
   20 CONTINUE
      RETURN
      END
```

SUBROUTINE TEST

```
$IBFTC TEST*    DECK
      SUBROUTINE TEST(M,N,MAT,NPR,ITEST)                                5493
C***  TESTS MATRIX MAP MAT(I) TO SEE IF PARTION 1000*M+N
C        APPEARS IN STIFFNESS MATRIX
      DIMENSION MAT(1)                                                  5494
      NUM=1000*M+N                                                      5498
      DO 1 I=1,NPR                                                      5499
      IF(NUM.EQ.MAT(I))GO TO 2                                          5500
    1 CONTINUE                                                          5501
      NUM=1000*N+M                                                      5502
      DO 10 I=1,NPR                                                     5503
      IF(NUM.EQ.MAT(I))GO TO 2                                          5504
   10 CONTINUE                                                          5505
      ITEST=0                                                           5506
      GO TO 3                                                           5507
    2 ITEST=1                                                           5508
    3 CONTINUE                                                          5509
      RETURN                                                            5510
      END                                                               5511
```

SUBROUTINE FKSORT

```
$IBFTC FKSRT    DECK
      SUBROUTINE FKSORT
C
C THIS SUBROUTINE CREATES THE NSAVE ARRAY WHICH CONTAINS THE LIST OF ELEMENT
C NUMBERS THAT ARE TO BE RETAINED AND THE NZ ARRAY WHICH CONTAINS THE NUMBER
C OF RETAINED ELEMENTS IN EACH PARTITION.
C
      COMMON/LASTND/LN(200)
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NMAX,NP
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/SORT/NSAVE( 7000),NZ(200)
      COMMON/CONT1/JPART(800)
      COMMON/CONTEM/NPRR,NPR
      COMMON/COMS/NSIZE(200)
      DIMENSION IR(60),NTEMP(800),IC(60)
C *** NOMENCLATURE ***    ***    ***    ***    ***    ***    ***    ***    ***    ***
C     NTOL = TOTAL NUMBER OF RETAINED FREEDOMS
C     NNZ COUNTS RETAINED FREEDOMS FOR THIS PARTITION
C     NZ = ARRAY CONTAINING THE NUMBER OF RETAINED FREEDOMS FOR EACH PARTITION
C     NSAVE = ARRAY OF ELEMENT NUMBERS OF THE STIFFNESS MATRIX WHICH ARE TO BE
C     RETAINED
C     IR = ARRAY CONTAINING REDUCTION INFORMATION FOR THIS PARTITION
C     IR(N) = 1 IF THE NTH FREEDOM IS TO BE RETAINED, AND ZERO IF IT IS TO BE
C     REDUCED.
C     LN = ARRAY CONTAINING LAST NODES FOR EACH PARTITION.
C     NMAX = TOTAL NUMBER OF PARTITIONS (ELEMENTS IN JPART ARRAY)
C     NPR = NUMBER OF KFF PARTITIONS (ELEMENTS IN NTEMP)
C
C THE NSAVE ARRAY IS CONSTUCTED AS SHOWN BELOW
C     NSAVE(1) = FIRST RETAINED ELEMENT NUMBER****
C     NSAVE(2) = 2ND   RETAINED ELEMENT NUMBER    *
C        *                  *                      *
C        *                  *                       *FIRST PARTITION
C        *                 ETC                     *
C        *                                        *
C     NSAVE(NZ(1)) = LAST RETAINED ELEM. NUMBER***
C     NSAVE(NZ(1)+1) = 1ST RET. ELEM. NUMBER      *
C     NSAVE(NZ(1)+2)   2ND RET. ELEM. NUMBER       *
C        *                  *                       *SECOND PARTTITION
C        *                  *                      *
C        *                 ETC.                   *
C     NSAVE(NZ(1)+NZ(2))**************************
C        *                                        *
C        *                                         *
C        *                                          *LAST PARTITION
C        *                                         *
C        *                                        *
C     NSAVE(NTOL) = LAST RET. ELEM. NUMBER********


C INITIALIZE ALL ARRAYS AND COUNTERS.
      IOUT = MT6
      N18 = MT1
      ISTIF = MT2
      IKBC = MT3
```

```
C
      REWIND N18
      REWIND ISTIF
      REWIND IKBC

      NPR = 0
      DO 4 K=1,NPS
      IF (NSIZE(K) .EQ. 0) GO TO 4
      NPR = NPR + 1
      NTEMP(NPR) = K*1000 + K
      IF (K .EQ. 1) GO TO 4
      NEND = K-1
      DO 3 I=1,NEND
      IF (NSIZE(I) .EQ. 0) GO TO 3
      CALL TEST (K,I,JPART,NMAX,ITEST)
      IF (ITEST .EQ. 0) GO TO 3
      NPR = NPR + 1
      NTEMP(NPR) = K*1000 + I
    3 CONTINUE
    4 CONTINUE

      DO 6 I=1,NPR
      JPART(I) = NTEMP(I)
    6 CONTINUE

      NTOL = 0
      DO 5 J=1,200
    5 NZ(J) = 0

C LOOP FOR EACH PARTITION
C
      DO 100 I=1,NP

C CALCULATE FIRST AND LAST NODE NUMBERS FOR THIS PARTITION
C
      IF(I .EQ. 1) GO TO 7
      N1 = LN(I-1) + 1
      N2 = LN(I)
      GO TO 8
    7 CONTINUE
      N1 = 1
      N2 = LN(1)
    8 CONTINUE
      NROW = 6*(N2-N1+1)
      M = 1

C READ RETAINED FREEDOMS FROM TAPE FOR ONE NODE AND ADD TO LIST FOR THIS PART.
C
      DO 10 N=N1,N2
      READ (N18) NCODE
      IF(NCODE .NE. N) GO TO 9990
      READ (N18) IR(M),IR(M+1),IR(M+2),IR(M+3),IR(M+4),IR(M+5)

C READ BOUNDARY CONDITIONS
      READ(IKBC) NODE,IJKLMN
      IF(NODE .NE. N) GO TO 9991
      CALL UNPACK(IJKLMN,IC(M),IC(M+1),IC(M+2),IC(M+3),IC(M+4),IC(M+5))
      ISP = 0
      M6 = M+5
      DO 9 IT=M,M6
      IF(IC(IT) .EQ. 3) ISP = 1
    9 CONTINUE
      IF(ISP .EQ. 1) READ(IKBC) D1,D2,D3,D4,D5,D6
      M = M+6
   10 CONTINUE
   20 CONTINUE
      NNZ = 0

C START SORTING LOOP
C
      J = 0
      DO 50 JJ=1,NROW
      IF((IC(JJ) .EQ. 0) .OR. (IC(JJ) .EQ. 3)) J = J + 1

C TEST FOR RETAINED FREEDOM
C
      IF(IR(JJ) .NE. 1) GO TO 50

C UPDATE COUNT OF RETAINED ELEMENTS AND ADD J TO ARRAY OF RETAINED ELEMENT NO.S
C
      NTOL = NTOL + 1
      NNZ = NNZ + 1
      NSAVE(NTOL) = J
   50 CONTINUE

C SAVE THE TOTAL NUMBER OF RETAINED FREEDOMS FOR THIS PARTITION
C
      NZ(I) = NNZ

  100 CONTINUE
      REWIND IKBC
      RETURN


 9990 WRITE (IOUT,9000) NCODE,N
      STOP
 9991 WRITE (IOUT,9001) NODE,N
      STOP


 9000 FORMAT(103H1ERROR IN SUBROUTINE FKSORT. THE PARTITION NUMBER READ
     *FROM TAPE DOES NOT AGREE WITH WHAT WAS EXPECTED.//27H PARTITION NU
     *MBER READ WAS I3,14H IT SHOULD BE I3)
 9001 FORMAT(//52H NODE NUMBER READ FROM IKBC IN FKSORT WAS INCORRECT./
     *16H NUMBER READ WAS,I8,5X,19HIT SHOULD HAVE BEEN,I8)
      END
```

SUBROUTINE KFFSRT

```
$IBFTC KFSRT   DECK
      SUBROUTINE KFFSRT
      COMMON/SORT/NSAVE( 7000),NZ(200),NPART(200),NPART2(200)
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP
      COMMON/COMS/NSIZE(200)
      COMMON/CONT1/MAT(800)
      COMMON/CONTEM/NPRR,NPR
      DIMENSION STIFF(60,60),SORTED(60,60),B(12)
C
C THIS SUBROUTINE SORTS THE KFF MATRIX INTO RETAINED (K11), DELETED (K22), AND
C DELETED-RETAINED (K21) PARTITIONS. IT THEN WRITES THEM ON TAPE IN TL01 FORMAT.
C
C*** NOMENCLATURE ***    ***    ***    ***    ***    ***    ***    ***    ***    ***    **
C      NP = TOTAL NUMBER OF PARTITIONS
C      NZ = ARRAY CONTAINING TOTAL NUMBER OF RETAINED FREEDOMS FOR EACH PARTITION
C      NSAVE = ARRAY OF RETAINED ELEMENT NUMBERS
C      ISIZE = SIZE OF THE PARTITION BEING PROCESSED.
C      STIFF = UNSORTED STIFFNESS MATRIX READ IN FROM TAPE
C      SORTED = SORTED STIFFNESS MATRIX WRITTEN OUT ON TAPE IN TL01 FORMAT
C
      IOUT = MT6
      KFF11 = MT16
      KFF12 = MT12
      KFF21 = MT2
      KFF22 = MT1
      KFF = MT11
C
      REWIND KFF11
      REWIND KFF12
      REWIND KFF21
      REWIND KFF22
      NFILE = 0
      NMAT =0
      REWIND KFF
      DO 205 K=1,NP
      NCNT = 0
      NCOUNT = 0
      NCNT1 = 0
      NCNT2 = 0
      DO 200 L=1,K
      DO 5 I=1,60
      DO 5 J=1,60
      SORTED(I,J) = 0.0
      STIFF(I,J) = 0.0
    5 CONTINUE
      N12 = 0
      N11 = 0
      ID = 1000*K + L
      CALL TEST (K,L,MAT,NPR,ITEST)
C
C IF THERE IS NO KOOL PARTITION, NULL MATRICES WILL BE WRITTEN ON TAPE
      ISIZEN = NSIZE(K)
      ISIZEM = NSIZE(L)
      IF (ITEST .NE. 1) GO TO 160
      N22 = NZ(K)
      N21 = NZ(K)
      IF(NSIZE(K) .EQ. 0) GO TO 201
      IF(NSIZE(L) .EQ. 0) GO TO 200
```

```
C
C CALCULATE LOCATION OF RETAINED FREEDOMS FOR THIS PARTITION
      IF (K .EQ. 1) GO TO 10
      NFIRST = 0
      DO 7 N1=2,K
      NFIRST = NFIRST + NZ(N1-1)
    7 CONTINUE
      NFIRST = NFIRST + 1
      GO TO 13
   10 NFIRST = 1
   13 NLAST = NFIRST + NZ(K) - 1
      IF(L .EQ. 1) GO TO 16
      MFIRST = 0

      DO 15 N2=2,L
      MFIRST = MFIRST + NZ(N2-1)
   15 CONTINUE
      MFIRST = MFIRST + 1
      GO TO 17
   16 MFIRST = 1
   17 MLAST = MFIRST + NZ(L) - 1
C
C READ STIFFNESS PARTITION (KFF) FROM TAPE.
      NAME = K*1000 + L
      CALL READTP(STIFF,60,NAME,NSIZE(K),NSIZE(L),B,0,0,KFF,IERR)
      IF (IERR .EQ. 1) GO TO 900
C
C IF NUMBER OF RETAINED FREEDOMS = 0, PLACE ALL ELEMENTS IN K22
      IF((NZ(K) .EQ. 0).AND.(NZ(L) .EQ. 0)) GO TO 150
C IF ALL FREEDOMS ARE RETAINED, PLACE ALL ELEMENTS IN K11
      IF((NZ(K) .EQ. ISIZEN) .AND. (NZ(L) .EQ. ISIZEM)) GO TO 140


      DO 100 N=1,ISIZEN
      M12 = NZ(L)
      M22 = NZ(L)
      M21 = 0
      M11 = 0
      IF (NZ(K) .EQ. 0) GO TO 21

      DO 20 NTEST=NFIRST,NLAST
      IF (NSAVE(NTEST) .EQ. N) GO TO 50
   20 CONTINUE

   21 CONTINUE
      N21 = N21+1
      N22 = N22+1

      DO 40 M=1,ISIZEM
      IF (NZ(L).EQ. 0) GO TO 31

      DO 30 MTEST=MFIRST,MLAST
      IF (NSAVE(MTEST) .EQ. M) GO TO 35
   30 CONTINUE

   31 CONTINUE
C PLACE THE N,M ELEMENT OF KFF INTO THE K22 PARTITION
      M22 = M22+1
      SORTED(N22,M22) = STIFF(N,M)
      GO TO 40
   35 CONTINUE
C PLACE THE N,M ELEMENT OF KFF INTO THE K21 PARTITION
      M21 = M21+1
      SORTED(N21,M21) = STIFF(N,M)
   40 CONTINUE
      GO TO 100

   50 CONTINUE
      N11 = N11+1
      N12 = N12+1

      DO 90 M=1,ISIZEM
      IF (NZ(L) .EQ. 0) GO TO 71

      DO 70 MTEST=MFIRST,MLAST
      IF (NSAVE(MTEST) .EQ. M) GO TO 75
   70 CONTINUE

   71 CONTINUE
C PLACE THE N,M ELEMENT OF KFF INTO THE K12 PARTITION
      M12 = M12+1
      SORTED(N12,M12) = STIFF(N,M)
      GO TO 90
   75 CONTINUE
C PLACE THE N,M ELEMENT OF KFF INTO THE K11 PARTITION
      M11 = M11+1
      SORTED(N11,M11) = STIFF(N,M)
   90 CONTINUE

  100 CONTINUE
      GO TO 160

C ALL FREEDOMS RETAINED. ALL ELEMENTS OF KFF GO INTO K11.
  140 CONTINUE
      ISIZEN = NSIZE(K)
      ISIZEM = NSIZE(L)
      NCNT1 = NCNT1 + 1
      CALL WRTETP(STIFF,60,ID,ISIZEN,ISIZEM,B,0,0,KFF11,IERROR)
      GO TO 200

C NO RETAINED FREEDOMS. ALL ELEMENTS OF KFF GO INTO K22.
  150 CONTINUE
      ISIZEN = NSIZE(K)
      ISIZEM = NSIZE(L)
      NCNT2 = NCNT2 + 1
      CALL WRTETP (STIFF,60,  ID,ISIZEN,ISIZEM ,  B,NFILE,NMAT,KFF22,
     *IERROR)
      GO TO 200
  160 CONTINUE

C WRITE OUT K22 PARTITION ONTO TAPE
      N = NZ(K) + 1
      M = NZ(L) + 1
      IROW = ISIZEN - NZ(K)
      ICOL = ISIZEM - NZ(L)
      IF ((IROW .EQ. 0) .OR. (ICOL .EQ. 0)) GO TO 170
      WRITE (IOUT,6500) ID,IROW,ICOL,KFF22
      NCNT2 = NCNT2 + 1
      CALL WRTETP (SORTED(N,M),60,   ID    ,IROW,ICOL,B,NFILE,NMAT,KFF22
     *,IERROR)
  170 CONTINUE

C WRITE OUT K21 PARTITION ONTO TAPE
      ICOL = NZ(L)
      IF ((IROW .EQ. 0) .OR. (ICOL .EQ. 0)) GO TO 180
      NCOUNT = NCOUNT+1
      CALL WRTETP (SORTED(N,1),60,     ID    ,IROW,ICOL,B,NFILE,NMAT,KFF21
     *,IERROR)
  180 CONTINUE

C WRITE OUT K12 PARTITION ONTO TAPE
      IROW = NZ(K)
      ICOL = ISIZEM - NZ(L)
      IF ((IROW .EQ. 0) .OR. (ICOL .EQ. 0)) GO TO 190
      NCNT = NCNT + 1
      CALL WRTETP(SORTED(1,M),60,ID,IROW,ICOL,B,0,0,KFF12,IERROR)
  190 CONTINUE

C WRITE OUT K11 PARTITION ONTO TAPE
      ICOL = NZ(L)
      IF ((IROW .EQ. 0) .OR. (ICOL .EQ. 0)) GO TO 200
      NCNT1 = NCNT1 + 1
      CALL WRTETP (SORTED(1,1),60,     ID    ,IROW,ICOL,B,NFILE,NMAT,KFF11
     *,IERROR)
  200 CONTINUE
  201 CONTINUE
      NPART2(K) = NCNT
      NPART(K) = NCOUNT
C
C WRITE END OF FILES ON ALL TAPES INDICATING THE END OF A ROW
      IF (NCOUNT .NE. 0) END FILE KFF21
      IF (NCNT .NE. 0) END FILE KFF12
      IF (NCNT1 .NE. 0) END FILE KFF11
      IF (NCNT2 .NE. 0) END FILE KFF22
  205 CONTINUE
      REWIND KFF22
      REWIND KFF21
      REWIND KFF12
      REWIND KFF11
      RETURN
  900 WRITE (IOUT,9000)
 9000 FORMAT(///48H ERROR IN READ THE KFF TAPE IN SUBROUTINE KFSORT)
      STOP
      END
```

SUBROUTINE CONECT

```
$IBFTC CNCT*    DECK
      SUBROUTINE CONECT
      COMMON/SORT/ NSAVE( 7000),NZ(200),NPART(200),NPART2(200)
      COMMON/TERMS/DUMMY(6),NP
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/COMS/NSIZE(200)
      DIMENSION ISIZE(200),JSIZE(200),NPARA(50),B(12),PARA(50)
      EQUIVALENCE (PARA,NPARA)

      IOUT = MT6
      NTAPE4 = MT4
      NTP11 = MT11
      KFF11 = MT16
      KFF22 = MT1
      K21 = MT16
      KFF21 = MT2
      KFF12 = MT12

      N = 0
      DO 10 I=1,NP
      IF(NZ(I) .EQ. 0) GO TO 10
      N = N+1
      ISIZE(N) = NZ(I)
   10 CONTINUE
      NUMBER = N
      N = 0

C SET JSIZE ARRAY
      DO 20 I=1,NP
      IF(NZ(I) .EQ. NSIZE(I)) GO TO 20
      N = N+1
      JSIZE(N) = NSIZE(I) - NZ(I)
   20 CONTINUE
      NUMB = N

C WRITE PARAMETERS IN FILE 1 OF NTAPE4
      REWIND NTAPE4
      NPARA(1) = NUMB
      NPARA(2) = 2*NUMB
      NPARA(3) = NUMBER
      PARA(4) = 1.0
      NPARA(5) = NUMBER
      DO 30 I=6,50
      NPARA(I) = 0.0
   30 CONTINUE
      NAME = 0
      CALL WRTETP(NPARA,1,NAME,50,1,B,0,0,NTAPE4,IERR)
      END FILE NTAPE4
C
C EXPAND KFF11 TAPE ONTO TAPE NTAPE4 (2ND FILE)
      CALL EXPAND(ISIZE,NUMBER,KFF11,NTAPE4)
      END FILE NTAPE4

C
C EXPAND KFF22 TAPE ONTO TAPE NTP11
      REWIND NTP11
      CALL EXPAND(JSIZE,NUMB,KFF22,NTP11)
      END FILE NTP11
      REWIND NTP11
      N = 0
C SET UP ARGUMENTS FOR EXTRAN

C ELIMINATE ZEROS FROM THE NPART ARRAY ONLY IF THE FIRST NON-ZERO
C  ELEMENT IS NOT EQUAL TO THE CORRESPONDING ELEMENT IN NPART2.
      INC = 0
      NZERO = 0
   50 INC = INC + 1
      IF(NPART(INC) .NE. 0) GO TO 60
      NZERO = NZERO + 1
      GO TO 50
   60 CONTINUE
      IF ((NZERO .NE. 0) .AND. (NPART(INC) .NE. NPART2(INC))) GO TO 110
      DO 70 I=1,NUMB
      NSUB = I + NZERO
      NPART(I) = NPART(NSUB)
   70 CONTINUE

C ELIMINATE ZEROS FROM THE NPART2 ARRAY
      INC = 0
      NZERO = 0
   80 INC = INC + 1
      IF(NPART2(INC) .NE. 0) GO TO 90
      NZERO = NZERO + 1
      GO TO 80
   90 CONTINUE
      DO 100 I=1,NUMBER
      NSUB = I + NZERO
      NPART2(I) = NPART2(NSUB)
  100 CONTINUE
  110 CONTINUE

      CALL EXTRAN(NPART,NPART2,NUMBER,NUMB,NTAPE4,K21,KFF21,KFF12)
      REWIND NTAPE4
      RETURN
      END
```

SUBROUTINE EXPAND

```
$IBFTC EXPND*  DECK
      SUBROUTINE EXPAND(ISIZE,NUMBER,KTAPE,ITAPE)
      DIMENSION TRANSP(60,60),TEMP(60,60),ISIZE(1),B(12)
C
C THIS SUBROUTINE EXPANDS THE K11 AND K22 PARTITIONS INTO FULL MATRIX FORM.
C **** TAPE USEAGE ****   ****   ****   ****   ****   ****   ****   ****   ****
C KTAPE CONTAINS INPUT IN LOWER TRIANGULAR FORM
C ITAPE CONTAINS OUTPUT IN FULL FORM
C ITAPE MUST BE POSITIONED PROPERLY BY CALLING ROUTINE
C *** NOMENCLATURE ***   ***   ***   ***   ***   ***   ***   ***   ***   ***
C      NROW = ROW OF PARTITIONS BEING FORMED
C      ISIZE = ARRAY CONTAING SIZES OF THE PARTITIONS
C      NROWR = ROW OF PARTITIONS IN WHICH WE READ THE PARTITION THAT WILL BE
C      TRANSPOSED AND WRITTEN IN THE PARTITION ROW BEING FORMED
C      ID = THE IDENTIFYING WORD THAT IS ASSCOIATED WITH A GIVEN PARTITION
C      N = INDICATES THE NUMBER OF ROWS THAT HAVE ALREADY BEEN FORMED
C      NUMBER = NUMBER OF ROWS (AND COLUMNS) OF PARTITIONS


      REWIND KTAPE
      N = 0
      L = 0
      NFILE = 1
      NZERO = 0
    5 CONTINUE
      IF(N .NE. 0) CALL FSF(N,KTAPE,IERRA)
      NROW = N+1
      NROWR = NROW
      IF(ISIZE(NROW).EQ. 0) GO TO 40
C
C READ ROW OF PARTITIONS AND ADD THEM TO THE NEW TAPE
      DO 10 I=1,NROW
      NCOL = I
      ID = 0
      CALL READTP(TEMP,60,ID,IROW,ICOL,B,0,0,KTAPE,IERROR)
      IF(IERROR .NE. 0) GO TO 990
      CALL WRTETP(TEMP,60,ID,IROW,ICOL,B,0,0,ITAPE,IERR)
      IF (IERR .NE. 0) GO TO 991
   10 CONTINUE
      IF (NROW .GE. NUMBER) GO TO 50

C FORWARD SPACE TO READ TRANSPOSE OF NEXT PARTITION TO BE WRITEN
   15 CONTINUE
      NROWR = NROWR + 1
      ID = 0
      CALL READTP(TEMP,60,ID,IROW,ICOL,B,NFILE,N,KTAPE,IERROR)
      IF(IERROR .NE. 0) GO TO 990
C
C FORM TRANSPOSE
      DO 20 I=1,IROW
      DO 20 J=1,ICOL
      TRANSP(J,I) = TEMP(I,J)
   20 CONTINUE
      IDT = (ID - (ID/1000)*1000)*1000 + ID/1000
      CALL WRTETP(TRANSP,60,IDT,ICOL,IROW,B,0,0,ITAPE,IERR)
      IF (IERR .NE. 0) GO TO 991
      IF(NROWR .GE. NUMBER) GO TO 30
      GO TO 15
   30 CONTINUE
      IF(NROW .GE. NUMBER) GO TO 50
      REWIND KTAPE
   40 N = N + 1
      GO TO 5
   50 CONTINUE
      REWIND KTAPE
      RETURN
  990 WRITE(6,9000) IERROR
 9000 FORMAT(1H1,23HREADTP ERROR IN EXPAND.,13H ERROR CODE =,I5)
      STOP
  991 WRITE(6,9001) IERR
 9001 FORMAT(1H1,23HWRTETP ERROR IN EXPAND.,13H ERROR CODE =,I5)
      STOP
      END
```

SUBROUTINE EXTRAN

```
$IBFTC EXTRN*  DECK
      SUBROUTINE EXTRAN(NP21,NP12,NP11,NP22,NTAPE4,K21,KFF21,KFF12)
C THIS SUBROUTINE CREATES A FULL K21 MATRIX USING BOTH K21 AND K12 TAPES OUTPUT
C FROM THE KFSORT AND ALSO A FULL K12 MATRIX (BY TRANSPOSING K21).
C**** TAPE USEAGE ****    ****    ****    ****    ****    ****    ****    ****
C NTAPE4 IS THE OUTPUT FOR K21 AND K12 IN FULL FORM. IT MUST BE POSITIONED AT
C THE BEGINING OF FILE 3 AT THE START OF THIS ROUTINE AND K12 WILL BE WRITTEN
C AS FILE 3 WITH K21 FOLLOWING IN FILE 4.
C**** NOMENCLATURE ****    ****    ****    ****    ****    ****    ****    ****
C      NP21 = ARRAY GIVING THE NUMBER OF PARTITIONS IN EACH ROW OF K21
C      NP12 = ARRAY GIVING THE NUMBER OF PARTITIONS IN EACH ROW OF K12
C      NP11 = NUMBER OF PARTITIONS IN K11
C      NP22 = NUMBER OF PARTITIONS IN K22
C      N = NUMBER OF ROWS OF PARTITIONS WRITTEN ON K21
C      M = NUMBER OF ROWS OF PARTITIONS WRITTEN FOR K12 (ON NTAPE4)
C      NMOD = NUMBER OF ROWS OF PARTITIONS READ FROM KFF21

      DIMENSION TEMP(60,60),TRANSP(60,60),B(12),NP21(1),NP12(1)

      IERR = 0
      IOUT = 6
      REWIND K21
      REWIND KFF21
      REWIND KFF12
      N = 0
      NMOD = 0

    5 CONTINUE
      AREA = 0.0
      IF (NMOD .GT. 0) CALL FSF(NMOD,KFF21,IERR)
      IF ((NMOD .GT. 0) .AND. (IERR .NE. 0)) GO TO 992
      NPART = NP21(N+1)
      IF (NPART .EQ. 0) GO TO 12

C COPY NPART PARTITIONS FROM KFF21 TAPE TO K21 TAPE
      DO 10 I=1,NPART
      ID = 0
      AREA  =  1.0
      CALL READTP(TEMP,60,ID,IROW,ICOL,B,0,0,KFF21,IERR)
      IF (IERR .NE. 0) GO TO 990
      AREA  =  2.0
      CALL WRTETP(TEMP,60,ID,IROW,ICOL,B,0,0,K21,IERR)
      IF (IERR .NE. 0) GO TO 990
   10 CONTINUE
      NMOD = NMOD + 1
   12 CONTINUE
      IF (NPART .GE. NP11) GO TO 25

C SKIP NSKIP ROWS OF PARTITIONS ON KFF12 TAPE

      NSKIP = NPART - 1
      IF (NSKIP .GT. 0) CALL FSF(NSKIP,KFF12,IERR)
      AREA  =  3.0
      IF ((NSKIP .GT. 0) .AND. (IERR .NE. 0)) GO TO 992

      NFILE = 1
      IF (NSKIP .LT. 0) NFILE = 0
      NSTART = NPART + 1
      DO 20 I=NSTART,NP11
      ID = 0
      AREA  =  4.0
      CALL READTP(TEMP,60,ID,IROW,ICOL,B,NFILE,N,KFF12,IERR)
      IF (IERR .NE. 0) GO TO 990

C FORM TRANSPOSE
      DO 15 J=1,IROW
      DO 15 K=1,ICOL
      TRANSP(K,J) = TEMP(J,K)
   15 CONTINUE

C WRITE OUT ON TAPE K21
      IDT = (ID - (ID/1000)*1000)*1000 + ID/1000
      AREA  =  5.0
      CALL WRTETP(TRANSP,60,IDT,ICOL,IROW,B,0,0,K21,IERR)
      IF (IERR .NE. 0) GO TO 990
      NFILE = 1
   20 CONTINUE


C UPDATE COUNT OF ROWS ALREADY FORMED
   25 CONTINUE
      N=N+1
      REWIND KFF21
      REWIND KFF12
      END FILE K21
      IF (N .GE. NP22) GO TO 30
      GO TO 5

C K21 COMPLETED
   30 CONTINUE
      REWIND K21

C FORM K12 ON TAPE 4
      M = 0
   32 CONTINUE
      NFILE = 0

      DO 40 I=1,NP22
      ID = 0
      AREA  =  6.0
      CALL READTP(TEMP,60,ID,IROW,ICOL,B,NFILE,M,K21,IERR)
      IF (IERR .NE. 0) GO TO 990

C FORM TRANSPOSE
      DO 35 J=1,IROW
      DO 35 K=1,ICOL
      TRANSP(K,J) = TEMP(J,K)
   35 CONTINUE
      IDT = (ID - (ID/1000)*1000)*1000 + ID/1000
      AREA  =  7.0
      CALL WRTETP(TRANSP,60,IDT,ICOL,IROW,B,0,0,NTAPE4,IERR)
      IF (IERR .NE. 0) GO TO 990
      NFILE =1
   40 CONTINUE

      M = M+1
      IF (M .GE. NP11) GO TO 50
      REWIND K21
      GO TO 32

C K12 COMPLETED
   50 CONTINUE
      REWIND K21
      END FILE NTAPE4


C WRITE K21 ONTO NTAPE4
      DO 60 I=1,NP22
      DO 55 J=1,NP11
      ID = 0
      AREA  =  8.0
      CALL READTP(TEMP,60,ID,IROW,ICOL,B,0,0,K21,IERR)
      IF (IERR .NE. 0) GO TO 990
      AREA  =  9.0
      CALL WRTETP(TEMP,60,ID,IROW,ICOL,B,0,0,NTAPE4,IERR)
      IF (IERR .NE. 0) GO TO 990
   55 CONTINUE
      IF (I .LT. NP22) CALL FSF(1,K21,IERR)
      IF ((I .LT. NP22) .AND. (IERR .NE. 0)) GO TO 992
   60 CONTINUE

C NTAPE4 COMPLETED
      END FILE NTAPE4
      REWIND K21
      RETURN

C ERROR COMMENTS
  990 WRITE (6,9000) AREA,IERR
      STOP
  992 WRITE (6,9002) AREA,IERR
      STOP
 9000 FORMAT(// 7H AREA =,F5.0,10X,13HERRROR CODE = I5)
 9002 FORMAT(//18H FSF ERROR. AREA =,F5.0,13H ERROR CODE =,I3)
      END
```

SUBROUTINE DELETE

```
$IBFTC DELET*  DECK
      SUBROUTINE DELETE(ITYPE,NELEM,NSTRS)
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP
      COMMON/RSIZE/ISIZE(500),NROW,JSIZE(200)
      COMMON/LASTND/LN(200)
      COMMON/MAPSTR/IPTOT,IBTOT
      COMMON/TEMPO/STRESS(96,60)
      DIMENSION SAVE(96),IC(60)

C THIS SUBROUTINE DELETES THE COLUMNS OF THE STRESS MATRIX THAT CORRESPOND TO
C CONSTRAINED DEGREES OF FREEDOM

C **** NOMENCLATURE ****    ****    ****    ****    ****    ****    ****    ****
C      ITYPE = TYPE OF ELEMENT IN STRESS MATRIX. 1 FOR BEAMS, 0 FOR PLATES
C      NELEM = THE MAXIMUM NUMBER OF ELEMENTS PER PARTITION
C      NSTRS = THE NUMBER OF STRESSES PER ELEMENT
C      ISIZE = THE ARRAY OF ROW DIMENSIONS FOR THE STRESS PARTITIONS
C      NROW = NUMBER OF ROWS OF PARTITIONS IN STRESS MATRIX BEING PROCESSED
C      JSIZE = COLUMN DIMENSIONS FOR STRESS PARTITIONS (SORTED)
C ****    ****    ****    ****    ****    ****    ****    ****    ****    ****


      NSTRES = MT12
      KSTRES = MT8
      IKBC = MT3
      IOUT = MT6
      REWIND NSTRES

C CALCULATE PARTITION COLUMN SIZE ARRAY
      DO 10 I=1,NP
      IF(I .EQ. 1) GO TO 5
      JSIZE(I) =(LN(I) - LN(I-1))*6
      GO TO 10
    5 CONTINUE
      JSIZE(I) = LN(I) *6
   10 CONTINUE

      IF (ITYPE .EQ. 1) NUMBER = NBEAM
      IF (ITYPE .EQ. 0) NUMBER = NPLATE
      IF(ITYPE .EQ. 1) NTOT = IBTOT
      IF(ITYPE .EQ. 0) NTOT = IPTOT
      NTOT2 = NTOT
      IREM = 0

C CALCULATE NUMBER OF ROWS OF PARTITIONS AND ROW DIMENSIONS
      NROW = NUMBER/NELEM
      IF (NUMBER - NROW*NELEM .EQ. 0) GO TO 15
      NROW = NROW + 1
      IREM = 1
   15 DO 20 I=1,NROW
      ISIZE(I) = NELEM*NSTRS
   20 CONTINUE
      IF (IREM .EQ. 1) ISIZE(NROW) =(NUMBER - (NROW - 1)*NELEM)*NSTRS
```

```
C BEGIN SORTING PROCESS

      NCOUNT = 0
C LOOP ON PARTITION ROWS
      DO 200 I=1,NROW
      REWIND IKBC

C LOOP ON PARTITION COLUMNS
      DO 190 J=1,NP
      IMAX = ISIZE(I)
      DO 25 I2=1,IMAX
      DO 25 J2=1,60
      STRESS(I2,J2) = 0.0
   25 CONTINUE

      ID = 1000*I + J
      IF(NCOUNT .GE. NTOT) GO TO 210
      READ (KSTRES) NCODE

C READ IN BOUNDARY CONDITIONS FROM IKBC
      IF (J .EQ. 1) GO TO 32
      N1 = LN(J-1) + 1
      N2 = LN(J)
      GO TO 33
   32 CONTINUE
      N1 = 1
      N2 = LN(J)
   33 CONTINUE
      M = 1

      DO 35  NN=N1,N2
      READ (IKBC) NODE,IJKLMN
      IF (NODE .NE. NN) GO TO 990
      CALL UNPACK(IJKLMN,IC(M),IC(M+1),IC(M+2),IC(M+3),IC(M+4),IC(M+5))
      ISP = 0
      M6 = M+5
      DO 34 IT=M,M6
      IF(IC(IT) .EQ. 3) ISP = 1
   34 CONTINUE
      IF(ISP .EQ. 1) READ(IKBC) D1,D2,D3,D4,D5,D6
      M = M + 6
   35 CONTINUE

      IF (NCODE .NE. ID) GO TO 180

C SORT THIS PARTITION (NCODE = ID)
      NCOUNT = NCOUNT + 1

C READ IN STRESS PARTITION FROM KSTRES
      IROW = ISIZE(I)
      ICOL = JSIZE(J)
      READ (KSTRES) ((STRESS(M,N),M=1,IROW),N=1,ICOL)

      ICON = 0

C COUNT FREEDOMS TO BE DELETED
      DO 40 NN=1,ICOL
      IF((IC(NN) .EQ. 1) .OR. (IC(NN) .EQ. 2)) ICON = ICON + 1
   40 CONTINUE
```

```
C TEST FOR NO CONSTRAINED FREEDOMS OR FOR ALL CONSTRAINED FREEDOMS
      IF (ICON .EQ. 0) GO TO 120
      IF(ICON .EQ. ICOL) NTOT2 = NTOT2 - 1
      IF (ICON .EQ. ICOL) GO TO 190


C BEGIN SORTING
      JS = 0
      JS1 = 0
      JS2 = 0
   50 JS = JS + 1

      IF((IC(JS) .NE. 1) .AND. (IC(JS) .NE. 2)) GO TO 100

C DELETE THIS COLUMN
      N1 = JS1 + 2
      N2 = ICOL
      DO 66 JNC1=N1,N2
      DO 65 INC1=1,IMAX
      STRESS(INC1,JNC1-1) = STRESS(INC1,JNC1)
   65 CONTINUE

   66 CONTINUE
      IF (JS .LT. ICOL) GO TO 50

  100 CONTINUE

C UPDATE COUNT OF RETAINED COLUMNS
      JS1 = JS1 + 1
      IF (JS .LT. ICOL) GO TO 50

C WRITE OUT THE NEW PARTITION ON TAPE NSTRES
      WRITE(NSTRES) NCODE
      WRITE(NSTRES)((STRESS(M,N),M=1,IROW),N=1,N2)
      GO TO 190

  120 CONTINUE


C ALL FREEDOMS RETAINED. NO SORTING NEEDED
      WRITE(NSTRES) NCODE
      WRITE(NSTRES) ((STRESS(M,N),M=1,IROW),N=1,ICOL)
      GO TO 190
  180 CONTINUE
      BACKSPACE KSTRES
  190 CONTINUE

  200 CONTINUE

  210 CONTINUE
      IF(ITYPE .EQ. 0) IPTOT = NTOT2
      IF(ITYPE .EQ. 1) IBTOT = NTOT2
      REWIND IKBC
      REWIND NSTRES
      RETURN


C ERROR COMMENT
  990 WRITE (IOUT,9000) NODE,NN
      STOP
```

```
9000 FORMAT(//87H NODE NUMBER READ FROM TAPE IN SUBROUTINE DELETE DOES
    *NOT AGREE WITH WHAT WAS EXPECTED./ 6H READ ,I8,5X,10H EXPECTED I8)
     END
```

SUBROUTINE SSORT

```
$IBFTC SSORT*  DECK
      SUBROUTINE SSORT(ITYPE,NELEM,NSTRS)
      COMMON/SORT/NSAVE(7000),NZ(200),NPART(200)
      COMMON/TAPES/MT1,MT2,MT3,MT4,MT5,MT6,MT7,MT8,MT9,MT10,MT11,MT12,
     * MT13,MT14,MT15,MT16,MT17
      COMMON/TERMS/NBEAM,NPLATE,NNODE,NCOND,NPS,NTOL,NP
      COMMON/RSIZE/ISIZE(500),NROW,JSIZE(200)
      COMMON/COMS/NSIZE(200)
      COMMON/MAPSTR/IPTOT,IBTOT
      COMMON/TEMPO/STRESS(96,60)
      DIMENSION SAVE(96),NPARA(50),PARA(50),SORTED(96,60),B(12)
      EQUIVALENCE(STRESS,SORTED),(NPARA,PARA)
C THIS SUBROUTINE SORTS THE STRESS MATRIX FOR EITHER BEAMS OR PLATES INTO TWO
C PARTS - S1 (RETAINED) AND S2 (REDUCED)
C*****NOMENCLATURE*****
C     ITYPE = TYPE OF STRESS MATRIX. 1 FOR BEAMS, 0 FOR PLATES
C     NELEM = THE MAXIMUM NUMBER OF ELEMENTS PER PARTITION
C     NSTRS = THE NUMBER OF STRESSES PER ELEMENT
C     NSIZE = ARRAY OF COLUMN DIMENSION FOR THE STRESS PARTITIONS
      IOUT = MT6
      KSTRES = MT12
      KS2 = MT16


      IF(ITYPE .EQ. 1) NTOT = IBTOT
      IF(ITYPE .EQ. 0) NTOT = IPTOT
      IF(ITYPE .EQ. 1) NUMBER = NBEAM
      IF(ITYPE .EQ. 0) NUMBER = NPLATE
C CALCULATE NUMBER OF ROWS OF PARTITIONS AND ROW DIMENSIONS

      NSTAPE = MT3
      IF (ITYPE .EQ. 0) NSTAPE = MT1
      REWIND NSTAPE
      REWIND KS2

C COUNT NUMBER OF S1 AND S2 PARTITIONS
      NS1 = 0
      NS2 = 0
      DO 4 I=1,NP
      IF (NZ(I) .NE. 0) NS1 = NS1 + 1
      IF (NZ(I) .NE. NSIZE(I)) NS2 = NS2 + 1
    4 CONTINUE

C SET PARAMETER MATRIX AND WRITE OUT AS FIRST FILE OF TAPE NSB OR NSP
      NPARA(1) = NS2
      NPARA(2) = 2*NS2
      NPARA(3) = NS1
      PARA(4) = 1.0
      NPARA(5) = NROW
      DO 6 I =6,50
    6 NPARA(I) = 0.0
      NAME = 0
      CALL WRTETP(NPARA,1,NAME,50,1,B,0,0,NSTAPE,IERROR)
      END FILE NSTAPE
      NCOUNT = 0

C LOOP ON PARTITION ROWS
```

```
      DO 200 I=1,NROW
C LOOP ON PARTITION COLUMNS
      DO 190 J=1,NP
      IMAX = ISIZE(I)
      DO 5 INC=1,IMAX
      DO 5 JNC=1,60
      STRESS(INC,JNC) = 0.0
    5 CONTINUE
      ID = 1000*I + J
      IF(NCOUNT .GE. NTOT) GO TO 150
      READ (KSTRES) NCODE
      IF (NCODE .NE. ID) GO TO 150
C THIS PARTITION IS TO BE SORTED BY COLUMNS.
      NCOUNT = NCOUNT + 1
      JS1 = 0
      JS2 = NZ(J)
C CALCULATE LOCATION OF RETAINED FREEDOMS FOR THIS PARTITION
      IF (J .EQ. 1) GO TO 20
      NFIRST = 0
      DO 15 N1=2,J
      NFIRST = NFIRST + NZ(N1-1)
   15 CONTINUE
      NFIRST = NFIRST + 1
      GO TO 23
   20 CONTINUE
      NFIRST = 1
   23 CONTINUE
      NLAST = NFIRST + NZ(J) - 1
C READ STRESS PARTITION FROM TAPE
      IROW = ISIZE(I)
      ICOL = NSIZE(J)
      READ (KSTRES) ((STRESS(IS,JS),IS=1,IROW),JS=1,ICOL)

C IF NO FREEDOMS ARE RETAINED, PLACE ELEMENTS IN S2.
      IF (NZ(J) .EQ. 0) GO TO 100
C IF ALL FREEDOMS ARE RETAINED, PLACE ELEMENTS IN S1
      IF (NZ(J) .EQ. NSIZE(J)) GO TO 90

C BEGIN SORTING LOOP
      JS = 0
      JS1 = 0
      JS2 = 0
   30 JS = JS + 1
      DO 40 NTEST=NFIRST,NLAST
      IF (NSAVE(NTEST) .EQ. JS) GO TO 60
   40 CONTINUE
C PLACE COLUMN IN S2
      JS2 = JS2 + 1
      N1 = JS1 + 1
      DO 50 IS2=1,IROW
      SAVE(IS2) = STRESS(IS2,N1)
   50 CONTINUE
      N2 = NZ(J)
      N3 = NZ(J) + JS2
      N4 = JS1 + 2

      DO 56 JNC1=N4,N2
      DO 55 INC1=1,IMAX
      STRESS(INC1,JNC1-1) = STRESS(INC1,JNC1)
   55 CONTINUE
   56 CONTINUE

      DO 57 INC1=1,IMAX
      STRESS(INC1,N2) = STRESS(INC1,N3)
   57 CONTINUE

      DO 58 INC2=1,IMAX
      STRESS(INC2,N3 ) = SAVE(INC2)
   58 CONTINUE

      GO TO 70

   60 CONTINUE
C PLACE COLUMN IN S1
      JS1 = JS1 + 1

   70 CONTINUE
      IF (JS .LT. NSAVE(NLAST)) GO TO 30
      GO TO 120

C ALL FREEDOMS RETAINED. PLACE ALL COLUMNS IN THE S1 PART
   90 CONTINUE
      CALL WRTETP(STRESS,96,ID,IROW,ICOL,B,0,0,NSTAPE,IERROR)
     *INTO S1)
      GO TO 190

C NO RETAINED FREEDOMS. PLACE ALL COLUMNS IN THE S2 PART.
  100 CONTINUE
      CALL WRTETP(STRESS,96,ID,IROW,ICOL,B,0,0,KS2,IERROR)
      GO TO 190

C WRITE OUT S1 AND S2 PARTS
  120 CONTINUE
      IROW = ISIZE(I)
      ICOL = NZ(J)
      J1 = NZ(J) + 1
      CALL WRTETP(STRESS(1,1),96,ID,IROW,ICOL,B,0,0,NSTAPE,IERROR)
      ICOL = NSIZE(J) - NZ(J)
      CALL WRTETP(STRESS(1,J1),96,ID,IROW,ICOL,B,0,0,KS2,IERROR)
      GO TO 190
C WRITE NULL PARTITIONS FOR S1 AND S2 ONTO TAPE
  150 CONTINUE
      IROW = ISIZE(I)
      ICOL = NZ(J)
      IF (NZ(J) .EQ. 0) GO TO 160
      CALL WRTETP(STRESS,96,ID,IROW,ICOL,B,0,0,NSTAPE,IERROR)
  160 CONTINUE
      IF (NZ(J) .EQ. NSIZE(J)) GO TO 170
      ICOL = NSIZE(J) - NZ(J)
      CALL WRTETP(STRESS,96,ID,IROW,ICOL,B,0,0,KS2,IERROR)
  170 CONTINUE
      BACKSPACE KSTRES
  190 CONTINUE
  200 CONTINUE

      REWIND KS2
      END FILE NSTAPE

C COPY S2 FROM KS2 TO FILE 3 OF NSTAPE
      DO 300 I=1,NROW
      DO 300 J=1,NS2
      ID = 0
      CALL READTP(STRESS,96,ID,IROW,ICOL,B,0,0,KS2,IERR)
      CALL WRTETP(STRESS,96,ID,IROW,ICOL,B,0,0,NSTAPE,IERROR)
  300 CONTINUE
      END FILE NSTAPE
      REWIND NSTAPE
      REWIND KS2
      RETURN

      END
```

SUBROUTINE FREMOD

```
$IBFTC FREMO*  DECK
      SUBROUTINE FREMOD
C
C     FORMULA NUMBERS 1 TO 5999 ARE NORMAL PROGRAM
C     FORMULA NUMBERS 6000 TO 7499 ARE DIAGNOSTICS
C     FORMULA NUMBER 7500 IS THE CALL EXIT STATEMENT
C     FORMULA NUMBERS 8000 TO 8999 ARE INPUT FORMATS
C     FORMULA NUMBERS 9000 TO 9999 ARE OUTPUT FORMATS
C
      DIMENSION DYNMAT(100,100), AMASS(100), CURNTD(100,100),
     1CMAT(100,3), FLEXIB(100,100), GUESS(100), TEMP1(100), VECMAT(100,
     225), TEMP(100), TEMPRY(100), TMPRY(100,3), DIAG(100), B(12),
     3NORMEL(25), FREQ(25), ITER(25), PCTBIG(25), CTMC(3,3), NTAPE(10),
     4BMASS(100),EVAL(100)
C
      EQUIVALENCE  (DYNMAT,FLEXIB,CURNTD,BMASS),(AMASS,VECMAT),
     1(DIFF,IDIFF), (IERNOW,ERRNOW), (ERROR,IERR), (ERLGST,IERLG),
     2               (DIFSML,IDFSML),                   (TMPRY(1,1),TEMP),
     3(TMPRY(1,2),TEMPRY),(TMPRY(1,3),TEMP1)
C
      INTEGER T6,T5
      T5 = 5
      T6 =6
      ITP=0
      PCTLMT=10.0
      MAXITR=1500
      NTAPED=3
      SF=1.0
C
   10 READ (T5,8000) N, MODES
C
  140 DO  145  I=1,N
      AMASS(I) = 0.0
      DO  145  J=1,N
      FLEXIB (I,J) = 0.0
  145 CONTINUE
C
C     READ FLEXIBILITY MATRIX
C
  150 NSTART=0
      NEND=0
      NSTART=NEND+1
      ITEMP = 10
      IPART=1
      NAME=0
      NFILE=0
      NMAT = 1
  175 REWIND ITEMP
      CALL READTP(FLEXIB(NSTART,NSTART),100,NAME,K,K,B,NFILE,NMAT,ITEMP
     1,IRR)
      IF(IRR.NE.0)GO TO 6015
  225 NEND=NEND+K
C
C     READ DIAGONAL MASS MATRIX
C
      READ(T5,8005) (AMASS(I),I=NSTART,NEND)
C
```

```
  450 WRITE(T6,9000)SF
      DO 475 I=1,N
  475 WRITE(T6,9005)I,(FLEXIB(I,J),J=1,N)
C
C     SCALE FLEXIBILITY MATRIX
C
  495 DO 500 I=1,N
      DO 500 J=1,N
  500 FLEXIB(I,J)=FLEXIB(I,J)*SF
C
C     FORM DYNAMIC MATRIX FROM FLEXIB AND AMASS
C
      DO 550 I=1,N
      DO 550 J = 1,N
 550  DYNMAT(I,J) = FLEXIB(I,J)*AMASS(J)
C     PUT ORIGINAL DYNAMIC MATRIX ON SCRATCH TAPE
C
 551  REWIND NTAPED
      CALL WRTETP(DYNMAT,100,0,N,N,B,0,0,NTAPED,IRR)
      IF(IRR.NE.0) GO TO 6055
  575 WRITE(T6,9010)
      DO 600 I=1,N
  600 WRITE(T6,9005)I,(DYNMAT(I,J),J=1,N)
C
C     WRITE OUT MASS MATRIX
C
 605  WRITE(6,9015) (I,AMASS(I),I=1,N)
      CALL WRTETP(AMASS,1,0,1,N,B,0,0,NTAPED,IRR)
      IF(IRR.NE.0)GO TO 6040
      ENDFILE NTAPED
      REWIND NTAPED
C
C     GET VALUES AND VECTORS.
C
      CALL VALVCT(DYNMAT,N,MODES,EVAL,VECMAT)
C
C     LOOP TO EXAMINE ROOTS 1 BY 1
C
      REWIND NTAPED
      CALL READTP(DYNMAT,100,0,N,N,B,0,0,NTAPED,IRR)
      IF (IRR.NE.0) GO TO 6060
      DO 1350 MODE=1,MODES
C
C     FORM  D V  AND  EVAL V TO SEE IF THIS MODE IS A
C     GOOD ONE.
C
      DIFSML=1.0E38
      DO 1250 I=1,N
      IF (ABS(VECMAT(I,MODE) - 0.01))1250,1175,1175
 1175 TEMPRY(I) = EVAL(MODE)*VECMAT(I,MODE)
      CALL INRPRD( DYNMAT(I,1),100,VECMAT(1,MODE),1,TEMP(I),N )
      DIFF = ABS(TEMP(I)-TEMPRY(I))*2.0/(ABS(TEMP(I)+TEMPRY(I)))
 1200 IF (IDFSML-IDIFF) 1250,1250,1225
 1225 DIFSML=DIFF
 1250 CONTINUE
      PCTBIG(MODE)=(1.0-DIFSML)*100.0
 1260 IF(PCTBIG(MODE).GE.0.0)GO TO 1270
 1265 PCTBIG(MODE)= 0.0
C
C     IS THE BEST PERCENTAGE GOOD ENOUGH
```

```
C
 1270 IF (PCTBIG(MODE)-PCTLMT) 1275,1325,1325
C
C     THIS MODE SHAPE IS NO GOOD, PRINT OUT ERROR
C
 1275 WRITE(T6,9055)MODE,PCTBIG(MODE),PCTLMT,(TEMPRY(I),I,TEMP(I),I=1,N)
C
C     MODE IS FOUND CORRECTLY -ARE MORE REQUESTED
C
 1325 IF (EVAL(MODE).LT.0.0) GO TO 6500
      IF(EVAL(MODE).EQ.0.0)GO TO 1330
      EVAL(MODE)=SQRT(1.0/EVAL(MODE))
 1330 FREQ(MODE)=EVAL(MODE)/6.28318530
 1350 CONTINUE
C
C     ALL DONE WITH FINDING VECTORS,FORM ORTHOGONALITY
C     MATRIX VT M V
C
      TMINDG=1.0E38
      TMAXDG=-TMINDG
      TMAXOD=TMAXDG
      CALL READTP(BMASS,1,0,NR,NC,B,0,0,NTAPED,IRR)
      IF (IRR .NE. 0) GO TO 6066
      WRITE(T6,9001)
      DO 1400 I=1,MODES
      DO 1360 J = 1,N
 1360 TEMP1(J) = VECMAT(J,I)*BMASS(J)
      DO 1375 J=1,MODES
 1375 CALL INRPRD (TEMP1   , 1  ,VECMAT(1,J),1,TEMP(J),N)
C
C     PRINT VT M V - ONE ROW
C
      WRITE(T6,9065)I,(TEMP(J),J=1,MODES)
      TEMPRY(I)=TEMP(I)
      DO 1400 J=1,MODES
      IF (I-J) 1380,1385,1380
 1380 TMAXOD=AMAX1(ABS(TEMP(J)),TMAXOD)
      GO TO 1400
 1385 TMAXDG=AMAX1(TEMP(J),TMAXDG)
      TMINDG=AMIN1(TEMP(J),TMINDG)
 1400 CONTINUE
      WRITE(T6,9060)TMAXDG,TMINDG,TMAXOD
C
C     PRINT INERTIA MATRIX
C
      WRITE(T6,9070)(I,TEMPRY(I),I=1,MODES)
C
C     PRINT MODE SHAPES
C
      K=MODES
      K1=1
      K2=6
      IF (K-6) 1430,1435,1435
 1430 K2=MODES
 1435 WRITE(T6,9075)K1,K2
      DO 1440 I=1,N
 1440 WRITE(T6,9076)(I,VECMAT(I,J),J=K1,K2)
      K=K-6
      IF (K) 1550,1550,1450
 1450 K1=K2+1
```

```
      IF (K-6) 1430,1430,1525
 1525 K2=K1+5
      GO TO 1435
C
C     WRITE OUT TABLE OF RESULTS
C
 1550 WRITE(T6,9080)(I,EVAL(I),FREQ(I),PCTBIG(I),I,I=1,MODES)
C
C
C     WRITE RESULTS ON TAPE IF DESIRED
C
 1575 NTAPOT = 10
      NAME=0
      NFILE = 2
      NMAT=0
C
C     WRITE FREQUENCIES, MODE SHAPES, INERTIA MATRIX, AND MASS MATRIX.
C
      CALL WRTETP (FREQ,1,NAME,MODES,1,B,NFILE,NMAT,NTAPOT,IRR)
      IF(IRR.NE.0)GO TO 6030
 1600 CALL WRTETP(VECMAT,100,NAME+1,N,MODES,B,0,0,NTAPOT,IRR)
      IF(IRR.NE.0)GO TO 6030
C
      CALL WRTETP(TEMPRY,1,NAME+2,1,MODES,B,0,0,NTAPOT,IRR)
      IF(IRR.NE.0)GO TO 6030
      END FILE NTAPOT
C
      CALL WRTETP(BMASS,1,NAME+3,1,N,B,0,0,NTAPOT,IRR)
      IF(IRR.NE.0)GO TO 6030
      END FILE NTAPOT
C
 1640 GO TO 7500
C
C     THE FOLLOWING ARE ALL DIAGNOSTIC PRINT EXITS
C
 6015 WRITE(T6,9100)
 6016 NTAPDG=ITEMP
      GO TO 7000
 6030 WRITE(T6,9115)NFILE,NMAT
      NTAPDG=NTAPOT
      GO TO 7000
 6040 WRITE(T6,9210)
      NTAPDG=NTAPED
      GO TO 7000
 6055 WRITE  (T6,9200)
 6056 NTAPDG = NTAPED
      GO TO 7000
 6060 WRITE  (T6,9205)
      GO TO 6056
 6066 WRITE  (T6,9215)
      GO TO 6056
 7000 WRITE(T6,9125)NTAPDG,IRR
      GO TO 7500
 6500 WRITE (T6,9155) EVAL,MODE
 7500 CALL UNLOAD (ITEMP)
      RETURN
 8000 FORMAT(5I10)
 8001 FORMAT(5I10/4I10,E20.0)
 8005 FORMAT (7E10.0)
 8010 FORMAT (I10,E10.0)
```

```
8015 FORMAT (I10/(7E10.0))
9000 FORMAT (1H1,5X,70HBELOW IS THE COMPLETE FLEXIBILITY MATRIX UNSCALE
    1D. THE SCALE FACTOR = 1PE16.6/1H0)
9001 FORMAT(1H1)
9005 FORMAT (1H0,I5,1P7E16.6/(E22.6,6E16.6))
9010 FORMAT (1H1,5X,28HBELOW IS THE DYNAMIC MATRIX./1H0)
9015 FORMAT(1H1,5X,25HBELOW IS THE MASS MATRIX./1H0/(10X,I5,F20.7) )
9055 FORMAT (1H1,5X,5HMODE I5,9HHAD ONLY F7.2,53H PERCENT ACCURACY, WHI
    1CH IS UNDER THE GIVEN LIMIT OF F7.2/1H0,5X,58HTHE TWO VECTORS WHIC
    2H SHOULD BE IDENTICAL ARE GIVEN BELOW./1H0/(20X,1PE16.7,3X,I5,2X,E
    316.7))
9060 FORMAT (1H0,5X,77HABOVE IS THE MATRIX V TRANSPOSE  M  V  ,WHERE V
    1IS THE MATRIX OF MODE SHAPES./1H0,5X,44HTHE MAXIMUM AND MINIMUM DI
    2AGONAL VALUES ARE F15.3,5H AND F15.3/1H0,5X,37HTHE MAXIMUM OFF DIA
    3GONAL MAGNITUDE = F15.8)
9065 FORMAT(1H0,I5,3X,1P9E12.2/(9X,1P9E12.2))
9070 FORMAT (1H1,5X,28HBELOW IS THE INERTIA MATRIX./1H0/(10X,I5,3X,F20.
    17))
9075 FORMAT (1H1,5X,31HBELOW ARE THE SHAPES FOR MODES I5,8H THROUGHI5/1
    1H0)
9076 FORMAT (6(3X,I3,F14.7))
9080 FORMAT (1H1,50X,22HTABLE OF FINAL RESULTS
    1/1H0,74X,10HPERCENTAGE
    2/33X,4HMODE,6X,7HRADIANS,10X,9HFREQUENCY,6X,8HACCURACY,7X,4HMODE
    3/33X,6HNUMBER,4X,10HPER SECOND,7X,6HIN CPS,9X,12HOF FREQUENCY,3X
    4,6HNUMBER/(1H0,32X,I3,5X,F14.7,4X,F14.7,4X,F8.3,4X,I3))
9100 FORMAT(1H1,38HFLEXIBILITY MATRIX COULD NOT BE FOUND.)
9115 FORMAT (1H1,65HSPACING ERROR OCCURED WHILE TRYING TO WRITE BINARY
    1TAPE. NFILE = I5,7HNMAT = I5)
9125 FORMAT (1H0,22HCURRENT TAPE IN USE = I5,14H ERROR CODE = I5)
9155 FORMAT(1H1,14H EIGENVALUE = E13.6,11H  FOR MODE I3,71H HAS A NEGAT
    1IVE VALUE, WHICH DOES NOT DESCRIBE A PROPER PHYSICAL SYSTEM)
9200 FORMAT(1H0,43HERROR WHILE WRITING DYNAMIC MATRIX ON TAPE.)
9205 FORMAT(1H0,45HERROR WHILE READING DYNAMIC MATRIX FROM TAPE.)
9210 FORMAT(1H0,40HERROR WHILE WRITING MASS MATRIX ON TAPE.)
9215 FORMAT(1H0,42HERROR WHILE READING MASS MATRIX FROM TAPE.)
     END
```

SUBROUTINE VALVCT

```
$IBFTC WDVALV  DECK
      SUBROUTINE VALVCT(D,N,MODES,EVALS,VECTRS)
      DIMENSION CN(100),SN(100),D(100,100),IR(100),ORDER(100),
     1 EVALS(100),VECTRS(100,25),X(100)
      INTEGER ORDER
      KR=100
C
C     SUBROUTINE HESSEN TRANSFORMS THE DYNAMIC MATRIX TO UPPER HESSENBERG
C     SUBROUTINE HESSEN USES TAPE 4
      CALL HESSEN(D,KR,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,ORDER,X)
C
C     SUBROUTINE QRITER TRANSFORMS THE HESSENBERG MATRIX TO TRIANGULAR,
C     THE EIGENVALUES ARE THE DIAGONAL ELEMENTS.
C     SUBROUTINE QRITER USES TAPE 2
      CALL QRITER(D,KR,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,ORDER,X)
C
C     SUBROUTINE SORTRT ORDERS THE ROOTS ACCORDING TO ABSOLUTE VALUE, LGST FIRST
      CALL SORTRT(D,KR,L,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,ORDER,X)
      ITMO=L-JL+1
      IF(ITMO.LT.MODES)MODES=ITMO
C
C     SUBROUTINE VECTOR COMPUTES THE VECTORS FOR THE TRIANGULAR MATRIX.
      CALL VECTOR(D,KR,L,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,ORDER,X)
C
C     SUBROUTINE TRANS1 TRANSFORMS THE VECTORS TO CORRESPOND TO THE
C     HESSENBERG MATRIX.
C     SUBROUTINE TRANS1 USES TAPE 2
      CALL TRANS1(D,KR,L,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,X)
C
C     SUBROUTINE TRANS2 TRANSFORMS THE VECTORS TO CORRESPOND TO THE
C     ORIGINAL MATRIX.
C     SUBROUTINE TRANS2 USES TAPE 4
      CALL TRANS2(D,KR,L,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,X)
 7500 RETURN
      END
```

SUBROUTINE HESSEN

```
$IBFTC WDHESS  DECK
      SUBROUTINE HESSEN(D,KR,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,ORDER,X)
      DIMENSION CN(KR),SN(KR),D(KR,KR),IR(KR),ORDER(KR),
     1 EVALS(KR),VECTRS(KR,1),X(KR)
      INTEGER ORDER,R,R2,R3
C
C     TRANSFORM ORIGINAL MATRIX TO UPPER HESSENBERG FORM.
      IH = 4
      REWIND IH
      N2 =N-2
      DO 100 R=1,N2
      R2= R+1
      XR = 0.0
      DO 50 I=R2,N
      XR2 =  ABS(D(I,R))
      IF(XR2.LE.XR)GO TO 50
      XR = XR2
      K = I
   50 CONTINUE
      IR(R) = 0
      IF(XR.EQ.0.0 )GO TO 100
      IF(K.EQ.R2)GO TO 65
      IR(R)=K
      DO 55 J=R,N
      XR = D(R2,J)
      D(R2,J) = D(K,J)
   55 D(K,J) =XR
      DO 60 I=1,N
      XR = D(I,R2)
      D(I,R2) = D(I,K)
   60 D(I,K) =XR
   65 R3 =R+2
      DO 80 I=R3,N
      IF(D(I,R).EQ.0.0 )GO TO 80
      XR =-D(I,R)/D(R2,R)
      DO 70 J=R2,N
   70 D(I,J) = D(I,J)+XR*D(R2,J)
      DO 75 J=1,N
   75 D(J,R2 )=D(J,R2 )-XR*D(J,I)
      D(I,R) = -XR
   80 CONTINUE
  100 CONTINUE
C
C     STORE UPPER HESSENBERG MATRIX ON TAPE,
C     USED TO TRANSFORM VECTORS TO CORRESPOND TO ORIGINAL MATRIX.
      WRITE(IH)((D(I,J),J=1,I),I=1,N)
      ENDFILE IH
      REWIND IH
      RETURN
      END
```

SUBROUTINE QRITER

```
$IBFTC WDQRIT  DECK
      SUBROUTINE QRITER(D,KR,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,ORDER,X)
      DIMENSION CN(KR),SN(KR),D(KR,KR),IR(KR),ORDER(KR),
     1 EVALS(KR),VECTRS(KR,1),X(KR)
      INTEGER ORDER
C
C     TRANSFORM UPPER HESSENBERG MATRIX TO TRIANGULAR FORM,
C     EIGENVALUES WILL BE THE DIAGONAL ELEMENTS.
      TOL = 1.E-14
      JS1 = 0
      JS2 = 0
      JCTR = 0
      IQ = 2
      LIMIT = 10
      REWIND IQ
      IDUM = 1
      IDUM2= 0
      N1=N-1
      J1=1
      ITER = 0
   40 ITER = ITER+1
      DO 50 I=1,N1
      IF( ABS(D(I+1,I)).GT. ABS(D(I+1,I+1))*TOL)GO TO 55
   50 CONTINUE
C
C     WRITE ZEROS ON TAPE TO INDICATE END OF DATA.
   52 WRITE(IQ)IDUM,IDUM,(IDUM2,I=1,4)
      REWIND IQ
      GO TO 7500
   55 11=I .
      J1P=J1+1
      DO 60 I=J1P,N1
      IF( ABS(D(I+1,I)).LE. ABS(D(I+1,I+1))*TOL) GO TO 65
   60 CONTINUE
      J2 = N
      GO TO 70
   65 J2 = I
   70 DO 75 I=1,N
      IF(D(I,I).NE.0.0 )GO TO 80
      WRITE(6,1100)I
   75 CONTINUE
      PRINT 1
      WRITE(6,1)
      CALL EXIT
   80 JL=I
   85 M = J2-1
      B = -D(M,M)-D(J2,J2)
      C = D(M,M)*D(J2,J2)-D(J2,M)*D(M,J2)
      RAD = B**2-4.0 *C
      IF(RAD.LT.0.0 )GO TO 90
      RAD =  SQRT(RAD)
      SHIFT = .50 *(-B+RAD)
      T = .50 *(-B-RAD)
      IF( ABS(SHIFT-D(J2,J2)).GT. ABS(T-D(J2,J2)))SHIFT = T
      GO TO 95
   90 SHIFT =-.50 *B
   95 DO 100 I=J1,J2
```

```
  100 D(I,I) = D(I,I)-SHIFT
C
C     DO QR PRE-MULT.
      DO 120 J= J1,M
  115 RAD =  SQRT(D(J+1,J)**2+D(J,J)**2)
      CN(J) = D(J,J)/RAD
      SN(J) = D(J+1,J)/RAD
      DO 120 I=J,N
      B = CN(J)*D(J,I)+SN(J)*D(J+1,I)
      D(J+1,I) = -SN(J)*D(J,I)+CN(J)*D(J+1,I)
  120 D(J,I) = B
C
C     DO QR POST-MULT.
      DO 140 J=J1,M
      JP = J+1
  135 DO 140 I=1,JP
      B = CN(J)*D(I,J)+SN(J)*D(I,J+1)
      D(I,J+1) = -SN(J)*D(I,J)+CN(J)*D(I,J+1)
  140 D(I,J) = B
      DO 150 I= J1,J2
  150 D(I,I) = D(I,I)+SHIFT
C
C     STORE ELEMENTS USED TO TRANSFORM VECTORS TO CORRESPOND TO HESSENBERG MTX.
      WRITE(IQ)J1,M,(SN(I),CN(I),I=J1,M)
      IF( JS1 .EQ. J1.AND. JS2 .EQ. J2 ) GO TO 200
      JCTR = 1
      JS1 = J1
      JS2 = J2
      IF( ITER .LT. 500 ) GO TO 40
      WRITE(6,1150)
      GO TO 52
 200  JCTR = JCTR + 1
      IF( JCTR .GE. LIMIT ) GO TO 250
      GO TO 40
 250  D(J2,J2-1)=0.
      GO TO 40
 7500 RETURN
 1    FORMAT(1H0,39HDIAGONAL OF TRANSFORMED MATRIX IS ZERO.)
 1100 FORMAT(1H0,16HDIAGONAL ELEMENT, I5, 9H IS ZERO.)
 1150 FORMAT(1H0,32HITERATION LIMIT OF 500 EXCEEDED.)
 1200 FORMAT(1H0,10I10)
 1300 FORMAT(1H0,8E16.8)
 1400 FORMAT(1H0,I5,(7E16.8))
      END
```

SUBROUTINE SORTRT

```
$IBFTC WDSORT  DECK
      SUBROUTINE SORTRT(D,KR,L,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,ORDER,X)
      DIMENSION CN(KR),SN(KR),D(KR,KR),IR(KR),ORDER(KR),
     1 EVALS(KR),VECTRS(KR,1),X(KR)
      INTEGER ORDER
C
      DO 20 I= 1,N
   20 X(I) = D(I,I)
C
C     ORDER THE ROOTS ACCORDING TO ABS.VALUE.
      DO 80 I= JL,N
      A = 0.0
      DO 60 J=JL,N
      IF( ABS(X(J)).LE.A)GO TO 60
      A =  ABS(X(J))
      ORDER(I) = J
   60 CONTINUE
      IF(A.EQ.0.0 )GO TO 85
      J = ORDER(I)
   80 X(J) = 0.0
      L = N
      GO TO 86
   85 L = I-1
C
C     MOVE THE ROOTS BACK INTO ARRAY X IN CORRECT ORDER.
   86 DO 90 I = JL,L
      M = ORDER(I)
   90 X(I) = D(M,M)
      M = JL+MODES-1
      IF(M.GT.L)M=L
C
C     CHECK FOR NEGATIVE ROOTS AMONG THE FREQUENCIES.
      DO 100 I=JL,M
      IF(X(I).GE.0.0)GO TO 100
      WRITE(6,1300)I,X(I)
  100 CONTINUE
      M2=0
      DO 130 I=JL,L
      M2=M2+1
 130  EVALS(M2) = X(I)
 7500 RETURN
 1300 FORMAT(1H0,I5,21H NEGATIVE EIGENVALUE=  ,E16.8)
      END
```

SUBROUTINE VECTOR

```
$IBFTC WDVECT  DECK
      SUBROUTINE VECTOR(D,KR,L,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,ORDER,X)
      DIMENSION CN(KR),SN(KR),D(KR,KR),IR(KR),ORDER(KR),
     1 EVALS(KR),VECTRS(KR,1),X(KR)
      INTEGER ORDER
C
C     COMPUTE VECTORS CORRESPONDING TO THE TRIANGULAR MATRIX.
      M = JL+MODES-1
      IF(M.GT.L)M=L
      DO 120 L5 = JL,M
      K = ORDER(L5)
      DO 50 I=JL,N
   50 X(I) = 0.0
      CURRT = D(K,K)
      DO 60 I = JL,K
   60 D(I,I) = D(I,I)-CURRT
      X(K) = 1.0
      J = K
   65 IF(J.EQ.JL) GO TO 80
      IF(D(J-1,J-1).EQ.0.0 ) GO TO 130
      SUM = 0.0
      DO 70 I = J,K
   70 SUM = SUM+D(J-1,I)*X(I)
      X(J-1) = -SUM/D(J-1,J-1)
      J = J-1
      GO TO 65
   80 DO 90 I = JL,K
   90 D(I,I) = D(I,I)+CURRT
      SUM = 0.0
      DO 100 I = JL,K
      CURRT =  ABS(X(I))
      IF(CURRT.GT.SUM)SUM = CURRT
  100 CONTINUE
      DO 110 I = JL,K
110   VECTRS(I,L5)=X(I)/SUM
      K1=K+1
      DO 115 I=K1,N
115   VECTRS(I,L5)=X(I)
120   CONTINUE
      GO TO 7500
  130 PRINT 1
      MODES=L5-1
 7500 RETURN
    1 FORMAT(38H0VECTOR SOL. FAILS DUE TO ZERO ON DIAG)
      END
```

SUBROUTINE TRANS1

```
$IBFTC WDTRN1  DECK
      SUBROUTINE TRANS1(D,KR,L,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,X)
      DIMENSION CN(KR),SN(KR),D(KR,KR),IR(KR),
     1 EVALS(KR),VECTRS(KR,1),X(KR)
C
C     TRANSFORM VECTORS TO CORRESPOND TO THE HESSENBERG MATRIX.
      IQ = 2
      DO 50 I = 1,N
      DO 50 J = 1,N
   50 D(I,J) = 0.0
      DO 60 I = 1,N
   60 D(I,I) = 1.00
   70 READ(IQ)J1,M,(SN(I),CN(I),I = J1,M)
      IF(SN(J1).EQ.0.0 .AND.CN(J1).EQ.0.0 ) GO TO 150
      DO 140 J = J1,M
      DO 140 I = 1,N
      SUM = CN(J)*D(I,J)+SN(J)*D(I,J+1)
      D(I,J+1) = -SN(J)*D(I,J)+CN(J)*D(I,J+1)
  140 D(I,J) = SUM
      GO TO 70
  150 REWIND IQ
      DO 170 I = 1,N
  170 X(I) = 0.0
      M = JL+MODES-1
      IF(M.GT.L)M=L
      DO 250 K = JL,M
      DO 200 I=JL,N
 200  X(I)=VECTRS(I,K)
      DO 240 I = 1,N
      VECTRS(I,K)=0.0
 240  CALL INRPRD(D(I,1),KR,X,1,VECTRS(I,K),N)
 250  CONTINUE
      RETURN
      END
```

SUBROUTINE TRANS2

```
$IBFTC WDTRN2  DECK
      SUBROUTINE TRANS2(D,KR,LIN,N,MODES,CN,SN,VECTRS,EVALS,JL,IR,X)
      DIMENSION CN(KR),SN(KR),D(KR,KR),IR(KR),
     1 EVALS(KR),VECTRS(KR,1),X(KR)
      INTEGER R,R2
C
C     TRANSFORM VECTORS TO CORRESPOND TO THE ORIGINAL MATRIX.
      IH = 4
      READ(IH)((D(I,J),J = 1,I),I = 1,N)
      N2 = N-2
      DO 300 K = 1,MODES
      JLK=JL+K-1
      IF(JLK.GT.LIN)GO TO 500
      DO 100 I=1,N
  100 X(I)=VECTRS(I,JLK)
      R=N2
      DO 175 I1=JL,N2
  160 R2 = R+2
      J=N
      DO 170 I2=R2,N
      X(J)=X(J)+D(J,R)*X(R+1)
  170 J=J-1
      L = IR(R)
      IF(L.EQ.0)GO TO 175
      SUM = X(L)
      X(L) = X(R+1)
      X(R+1) = SUM
  175 R=R-1
      SUM = 0.0
      DO 180 I = 1,N
      IF( ABS(X(I)).GT. ABS(SUM)) SUM=X(I)
  180 CONTINUE
      DO 190 I = 1,N
  190 X(I) = X(I)/SUM
  200 DO 250 I=1,N
  250 VECTRS(I,K)=X(I)
  300 CONTINUE
  500 RETURN
      END
```

SUBROUTINE AMERGE

```
$IBFTC AMERG*  DECK
      SUBROUTINE AMERGE( ITAPE, NTAPE, NF1 )
C**** SUBROUTINE TO FORM FULL STIFFNESS.AND FLEXIBILITY MATRIX FROM
C                SUB-MATRICES
C
C                 *                                             *
C                *S U B R O U T I N E   M E R G E                *
C                *                                                *
C                *  MERGES THE STIFFNESS/FLEXIBILITY MATRIX       *
C                 **                                             *
C                                                               *
C
C        NT         FINAL STIFFNESS/FLEXIBILITY MATRIX SIZE
C        NROW       NO OF ROW PARTITIONS TO MERGE
C        NCOL       NO OF COL PARTITIONS TO MERGE
C
C        SMAT(I,J)  FINAL MERGED NT X NT MATRIX
C
C        NPRNTK = 0 NO PRINTOUT OF STIFFNESS MATRIX
C               = NOT 0  PRINTOUT THE STIFFNESS MATRIX
C
C     ITAPE - A PARAMETR MATRIX, STIFFNESS MATRIX AND THE FLEXIBILITY
C             MATRIX IS STORED ON THIS TAPE.
C     NTAPE - THE MERGED MATRIX IS STORED ON THIS TAPE
C     NF1=1  IF THE STIFFNESS MATRIX IS DESIRED
C     NF1=2  IF THE FLEXIBILITY MATRIX IS DESIRED
C     THE FLEX MATRIX IS USED AS INPUT TO EIGENVALUE-EIGENVECTOR ROUTINE TV-105W
C     THE MAX SIZE OF THE STIFFNESS AND FLEX MATRIX IS (100X100)
C
C
C
       COMMON /PRNT/ NPRNTK
      DIMENSION SMAT(100,100), SCRAT(60,60),B(16), PARAM(50), IPARAM(50)
      EQUIVALENCE (PARAM,IPARAM)
      REWIND ITAPE
      ISUM=0
      JK=0
      IJ=0
      NT=0
      NST = NF1
      NAME=0
      NFILE = 0
      NMAT = 0
      CALL READTP(PARAM,1,NAME,M,N,B,NFILE,NMAT,ITAPE,IRR)
      IF(IRR .NE. 0) GO TO 1010
      NROW=IPARAM(5)
      NCOL=IPARAM(3)
      NMAT = 0
      NFILE = 0
      M=0
C
C
      DO 500 II=1,NROW
      JSUM=0
      ISUM=ISUM+M
      N=0
      NT=NT+M
      DO 500 I=1,NCOL
      JSUM=JSUM+N
      NAME=0
      CALL READTP(SCRAT,60,NAME,M,N,B,NF1,NMAT,ITAPE,IRR)
      IF(IRR .NE. 0)GO TO 1010
      NF1 = 0
      DO 200 J=1,M
      IJ=ISUM+J
      DO 100 K=1,N
      JK=JSUM+K
  100 SMAT(IJ,JK)=SCRAT(J,K)
  200 CONTINUE
  500 CONTINUE
C
C
      NT=NT+M
      NAME = 0
      NFILE = 0
      NMAT = 0
      CALL WRTETP(SMAT,100,NAME,NT,NT,B,NFILE,NMAT,NTAPE,IRR)
      IF(IRR .NE. 0)GO TO 1020
      IF( NST .NE. 1 ) GO TO 7500
      IF( NPRNTK .EQ. 0 ) RETURN
      WRITE(6,9600) NT,NT
C
      DO 9800 I = 1,NT
      WRITE(6,9720)I,(SMAT(I,J),J=1,NT )
 9800 CONTINUE
C
      GO TO 7500
 1010 WRITE (6,6001) IRR
      GO TO 7500
 1020 WRITE (6,6002) IRR
 6001 FORMAT(22H1ERROR CODE IN READTP=,I3)
 6002 FORMAT(22H1ERROR CODE IN WRTETP=,I3)
 9600 FORMAT(1H1,40X,17H STIFFNESS MATRIX ,8X,I3,4H BY I3/1H0 )
 9720 FORMAT(1H0,I5,1P7E16.6/(E22.6,6E16.6) )
 7500 RETURN
      END
```

SUBROUTINE SMERGE

```
$IBFTC SMERG*  DECK
      SUBROUTINE SMERGE ( ITAPE,NTAPE,ITEST )
C***  SUBROUTINE TO MERGE AND REPARTITION THE STRESS MATRIX
C
C            *                                                    *
C            * M E R G E    R O U T I N E    T O    M E R G E     *
C           *                                                      *
C           *  A N D    R E P A R T I T I O N    S T R E S S E S   *
C           *                                                      *
C            * F O R    P L A T E S    A N D    B E A M S         *
C            *                                                    *
C
C         ITEST = 8   PLATES
C               = 6   BEAMS
C
C
C         NSTRSP = 0       DONT MERGE THE STRESS FOR PLATES
C                NOT 0     MERGE THE STRESS FOR PLATES
C
C         NSTRSB = 0       DONT MERGE THE STRESS FOR BEAMS
C                NOT 0     MERGE THE STRESS FOR BEAMS
C
C
C
C     ITAPE - THE PARAMETER AND STRESS MATRIX IS STORED ON THIS TAPE
C     NTAPE - THE MERGED MATRIX IS STORED ON THIS TAPE
C
C***ICNT1       COUNT OF END 1 OR END 2
C***ICNT2       COUNT OF NUMBER OF BEAM ELEMENTS
C
      COMMON/PRNT/NPRNTK,NSTRSP,NSTRSB
      DIMENSION SMAT(96,100),SCRAT(96,60),B(16),IPARAM(50),PARAM(50),
     1 DMAT(8,100)
      EQUIVALENCE ( PARAM,IPARAM )
      REWIND ITAPE
      JK = 0
      NT = 0
      NAME = 0
      NFILE = 0
      NMAT  = 0
      CALL READTP( PARAM,1,NAME,M,N,B,NFILE,NMAT,ITAPE,IRR )
      IF( IRR .NE. 0 ) GO TO 1010
C***  THE NO. OF COL. PARTITIONS IS NCOL AND ROW PARTITIONS IS NROW
C
C
      NROW = IPARAM(5)
      NCOL = IPARAM(3)
      NMAT = 0
      NFILE = 0
      M = 0
C
C
      NF1 = 1
      IF( ITEST .EQ. 8 ) GO TO 50
      IF ( NSTRSB .EQ. 0 ) GO TO 60
      WRITE(6,9000)
      GO TO 60
```

```
 50    IF( NSTRSP .EQ. 0 ) GO TO 60
       WRITE(6,9001)
 60    CONTINUE
C***             INITIALIZE ICNT1 AND ICNT2
       ICNT1 = 1
       ICNT2 = 0
       DO 600 II = 1,NROW
C
C
       JSUM = 0
       N = 0
       NC= 0
C
       DO 500 I = 1,NCOL
       JSUM = JSUM + N
       NAME = 0
       CALL READTP(SCRAT,96,NAME,M,N,B,NF1,NMAT,ITAPE,IRR )
       IF( IRR .NE. 0 ) GO TO 1010
       NF1 = 0
       DO 200 J = 1,M
       DO 100 K = 1,N
       JK = JSUM + K
       NK = JK
 100   SMAT(J,JK) = SCRAT(J,K)
 200   CONTINUE
       NC = NC + N
C
 500   CONTINUE
C
C***   RE-PARTITION FOR EACH ELEMENT OF BEAM OR PLATE
       JJ = 0
C***   SET ITEST = 8  FOR PLATES
C***   SET ITEST = 6 FOR BEAMS
       NT = NT + M
       IJ = 0
       DO 550 I = 1,M
       JJ = JJ + 1
       IJ = IJ + 1
       DO 505 J = 1,NC
       DMAT(JJ,J) = SMAT(IJ,J)
 505   CONTINUE
       NMAT = 0
       NAME = 0
       IF( JJ .LT. ITEST ) GO TO 550
       JJ = 0
       CALL WRTETP( DMAT,8,NAME,ITEST,NC,B,NFILE,NMAT,NTAPE,IRR )
       IF( IRR .NE. 0 ) GO TO 1020
C
C
       IF( ITEST .EQ. 8 ) GO TO 510
       IF( NSTRSB .EQ. 0 ) GO TO 550
C***   P R I N T   O U T   B E A M   S T R E S S E S ( 6 X N )
       IF( ICNT2 .NE. 0 ) GO TO 506
       ICNT2 = ICNT2 + 1
       WRITE(6,9002) ICNT2
       GO TO 508
 506   IF( ICNT1 .EQ. 2 ) GO TO 508
       ICNT1 = 1
       ICNT2 = ICNT2 + 1
       WRITE(6,9002) ICNT2
```

```
  508  WRITE(6,9006) ICNT1
       DO 509 LL = 1,ITEST
       WRITE(6,9003) LL,( DMAT(LL,MM),MM=1,NC )
  509  CONTINUE
       ICNT1 = ICNT1 + 1
       GO TO 550
  510  IF( NSTRSP .EQ. 0) GO TO 550
C***   P R I N T    O U T    P L A T E    S T R E S S E S ( 8 X N )
       ICNT2 = ICNT2 + 1
       WRITE(6,9004) ICNT2
       DO 520 LL = 1,ITEST
  520  WRITE(6,9005) LL, ( DMAT(LL,MM),MM = 1,NC )
C
C
  550  CONTINUE
C
C
  600  CONTINUE
C
C
C
       GO TO 7500
 1010  WRITE(6,6001)IRR
       GO TO 7500
 1020  WRITE(6,6002)IRR
       GO TO 7500
 6001  FORMAT(22H ERROR CODE IN READTP= I3 )
 6002  FORMAT(22H ERROR CODE IN WRTETP= I3 )
 9000  FORMAT(1H1,40X,21H BEAM STRESS MATRICES /1H0 )
 9001  FORMAT(1H1,40X,22H PLATE STRESS MATRICES /1H0 )
 9002  FORMAT(1H0,5HBEAM I3 )
 9003  FORMAT(1H0,13X,I3,1P7E16.6/(17X,7E16.6) )
 9004  FORMAT(1H0,5HPLATEI3)
 9005  FORMAT(1H0,8X,I3,1P7E16.6/(12X,7E16.6) )
 9006  FORMAT(1H0,8X,3HENDI2)
 7500  RETURN
       END
```

PHASE I TL01 DATA LISTING

```
8000B                                            200B        29B       CLEAR
8200B                                                        0B        LOAD AND EXEC.
                  9000B                                      0B
                  -4000000B                                  0B
                  -8000000B                                  0B
                  -11000000B                                 0B
                  -12000000B                                 0B
4000000B                            8000B                    0B
8003B                               8004B             8005B  27B
                  4003000B                                   0B
1008B                                            8003B       0B        IS K22 UNPARTITIONED
11000000B                           1B                       0B
1B                                  1B                       18B
4000000B                            2B                       0B
1B                2B                3B                       6B
3B                                  8000000B                 0B
-3B                                              8005B       0B
1079B                                            999B        0B
11000000B                           1B                       0B
1B                                  8000000B                 0B
-2B                                              8003B       0B
4000000B                            1B                       0B
1B                                  8000000B                 0B
-2B                                              8005B       0B
-6B                                              8003B       0B
                  -4000000B                                  0B
                  -8000000B                                  0B
                  -11000000B                                 0B
8005B                                            4B          29B
8003B                               8006B        0B          27B       SAVE N FOR LOOPING
8003B                                            -1B         27B       DECREMENT N
8004B                                            -1B         27B       DECREMENT K
8000000B                            1B                       0B        PIVOT PARTITION         VT1
1B                                  1B           0B          18B       INVERT
-1014B            -1B                            1000B       27B
8000000B                            2B                       0B        REST OF PIVOT ROW       VT2
1B                2B                3B           0B          6B        NEW PIVOT ROW
-1014B                                           100B        27B       CHANGE NAME
3B                                  11000000B                0B        ON TAPE 2
-4B                                              8004B       0B        ALL OF PIVOT ROW
                  11000000B                                  0B
                  -11000000B                                 0B
8000000B                            1B                       0B        PART. TO BE ZEROED      VT3
11000000B                           2B                       0B        PIVOT ROW
1B                2B                3B           22B         6B        MULTIPLY
3B                                  2B           23B         0B        COPY
8000000B                            3B                       0B        ROW OF ZERO             VT4
3B                2B                3B           0B          2B        NEW TERM OF ROW
-1014B                                           10B         27B       CHANGE NAME
3B                                  12000000B                0B        TO TAPE 1 OR 3          VT5
-7B                                              8004B       0B        ALL TERMS OF ROW
-10B                                             8003B       0B        FOR N-1 ROWS
                  -8000000B                                  0B                                VT6
                  -11000000B                                 0B
11000000B                           1B                       0B        PIVOT ROW
1B                                  12000000B                0B        TO TAPE 3 OR 1          VT7
-2B                                              8004B       0B        ALL OF THE ROW
                  12000000B                                  0B                                VT8
                  -12000000B                                 0B                                VT9
                  -11000000B                                 0B
```

```
1013B                            8005B      0B      EVERY OTHER TIME
-1291B     -1B                   4000000B   27B     CHANGE VT1 TO 3
-1271B     -1B                   4000000B   27B     CHANGE VT2 TO 3
-1211B     -1B                   4000000B   27B     CHANGE VT3 TO 3
-1181B     -1B                   4000000B   27B     CHANGE VT4 TO 3
-1163B     -1B                   -4000000B  27B     CHANGE VT5 TO 1
-1142B     -1B                   -4000000B  27B     CHANGE VT6 TO 3
-1123B     -1B                   -4000000B  27B     CHANGE VT7 TO 1
-1112B     -1B                   -4000000B  27B     CHANGE VT8 TO 1
-1112B     -1B                   4000000B   27B     CHANGE VT9 TO 1
8005B                            1B         29B     CLEAR
8005B                            2B         27B     SET UP FOR NEXT
1011B                            255B       0B      TO END POINT
-1411B     -1B                   -4000000B  27B     CHANGE VT1 TO 1
-1391B     -1B                   -4000000B  27B     CHANGE VT2 TO 1
-1331B     -1B                   -4000000B  27B     CHANGE VT3 TO 1
-1301B     -1B                   -4000000B  27B     CHANGE VT4 TO 1
-1283B     -1B                   4000000B   27B     CHANGE VT5 TO 3
-1262B     -1B                   4000000B   27B     CHANGE VT6 TO 1
-1243B     -1B                   4000000B   27B     CHANGE VT7 TO 3
-1232B     -1B                   4000000B   27B     CHANGE VT8 TO 3
-1232B     -1B                   -4000000B  27B     CHANGE VT9 TO 3
8005B                            1B         29B     CLEAR
-52B                             8006B      0B
1007B                            8004B      0B
1002B                            8005B      0B      IF 8005=0 SOLUTION ON 8
1004B                            999B       0B      LEAVE ON TP 8
12000000B             1B                    0B
1B                    8000000B              0B      COPY ONTO TP 8
-2B                              8006B      0B
1006B                            999B       0B
1005B                            8005B      0B      IF 8005=0 SOLUTION IS ON 8
8000000B              1B                    0B
1B                    12000000B                     COPY ONTO 12
-2B                              8004B      0B
-3B                              8006B      0B
           -4000000B                        0B
           -8000000B                        0B
           -11000000B                       0B
           -12000000B                       0B
8175B      1B                    9B         20B

      PHASE 1.1  IS COMPLETE
8000B                            200B       29B     CLEAR 200 CELLS
8200B                                       0B      LOAD+EXECUTE
           -4000000B                        0B      REW 4
           -2000000B                        0B
           -8000000B                        0B      REW 8
           -11000000B                       0B      REW 11
           -12000000B                       0B
           -16000000B                       0B
           9000B                            0B      PARTITION
4000000B              8000B                 0B      READ PARAMETERS
8000B                 2000000B              0B      COPY PARAMETERS
           2000000B                         0B      EOF T2
1082B                            8005B      27B
1002B                            8003B      0B      ONE ROW PARTITION
1013B                            999B       0B
1004B                            8005B      0B      ONE COL PARTITION
1011B                            999B       0B
```

```
1012B                         1B        27B
          12000000B                     0B         FS T12/F0/M(I)
1002B                         999B      0B
          11999999B                     0B
12000000B           1B                  0B
1B                  8000000B            0B         X=(K22)INV*K21
-3B                           8003B     0B         FORM A COLUMN
          -12000000B                    0B
-8B                           8005B     0B
          8000000B                      0B         EOF
          -8000000B                                INITIAL REWINDS
          4002000B                      0B
4000000B            1B                  0B         READ K12
1B                  11000000B           0B         STORE K12
-2B                           8003B     0B         CYCLE N TIMES
          11000000B                     0B         EOF
-4B                           8005B     0B         CYCLE M TIMES
          -11000000B                    0B         REW 11
          -4000000B                     0B
11000000B           1B                  0B         READ K12
8000000B            2B                  0B         READ K22-1*K21
1B        2B        3B                  6B         MULTIPLY
3B                  1B                  0B         COPY
1004B                         999B      0B
11000000B           2B                  0B         READ K12
8000000B            3B                  0B         K22-1 * K21
2B        3B        1B                  30B        MULTIPLY
-3B                           8003B     0B         CYCLE N-1
1001B                         999B      0B
          4001000B                      0B
-1021B                        2B        27B
4000000B            2B                  0B         READ K11
2B        1B        2B                  2B         SUBTRACT
2B                  2000000B            0B
          -11001000B                    0B         BS T11/F1/M0
-16B                          8005B     0B
          -8000000B                     0B         REW 8
          11001000B                     0B         FS T11/F1/M0
-19B                          8005B     0B
          2000000B                      0B
          -11000000B                    0B         REW 11
          -2000000B                     0B
8000000B            1B                  0B
1B                  16000000B           0B
-2B                           8003B     0B
-3B                           8005B     0B
          16000000B                     0B
          -16000000B                    0B
          -8000000B                     0B         REW 8
          -4000000B                     0B         REW 4
8160B     1B                  9B        20B        PRINT COMMENT
                                                   EXIT                 +
      PHASE 1.2  IS COMPLETE


8000B                         100B      29B
8100B                                   0B         LOAD
          -4000000B                     0B
          -2000000B                     0B
          9000B                         0B         PARTITION
```

```
4000000B                    8000B                     0B        READ PARAMETERS
              -4000000B                               0B        REW 4
              2001000B                                0B
8075B                                     9B          19B       PRINT TITLE
2000000B                    1B                        0B        READ K INV
1014B                                     1B          27B       PREPARE NAME
1B                          1B            1000B       0B
1B                                        8075B       20B       PRINT K INV
-4B                                       8005B       0B        CYCLE M
-1034B                                    -1B         27B       DECREMENT NAME
-1B                                       8005B       0B
-1054B        -1B                         1000B       27B       INCREMENT NAME
-8B                                       8005B       0B        CYCLE M
              -2000000B                               0B        REW 7-B1
8055B         1B                          9B          20B       COMMENT
                                                                EXIT                  +
              K RED -- MATRIX NUMBER = I*1000 + J
              PRINTING OF K RED IS COMPLETE


8000B                                     200B        29B       CLEAR
8200B                                                 0B        LOAD+EXECUTE
              -4000000B                               0B        REW 4
              -8000000B                               0B        REW 8
              -11000000B                              0B        REW 11
              -2000000B                               0B        REW 2
              9000B                                   0B        PARTITION
4000000B                    8000B                     0B        READ PARAMETERS
              -4000000B                               0B
              2001000B                                0B        FS T2/F1/M0
1009B                                     999B        0B
2000000B                    1B                        0B        READ K
1B            1B            2B                        2B        SUBTRACT
2B            8006B         2B                        17B       ADD 1.0 TO DIAOGNAL
2B                          11000000B                 0B        STORE IDENTITY MAT
2000000B                    1B                        0B        READ K
1B            1B            2B                        2B        SUBTRACT
2B                          11000000B                 0B
-3B                                       8005B       0B        CYCLE M
-8B                                       8005B       0B
2000000B                    1B                        0B        READ K
1B            1B            2B                        2B        NULL MATRIX
2B            8006B         2B                        17B       ADD 1.0 TO DIA
2B                          11000000B                 0B
              11000000B                               0B
              -11000000B                              0B        REW 11
              -2001000B                               0B        BS T2/F1/M0
2000000B                    1B                        0B        READ K L.HS
1B                          8000000B                  0B
-2B                                       8005B       0B
11000000B                   1B                        0B        READ R.H.S
1B                          8000000B                  0B
-2B                                       8005B       0B        CYCLE M
-6B                                       8005B       0B        CYCLE M
              8000000B                                0B        EOF
              11000000B                               0B        REW 11
              -8000000B                               0B        REW 8
              2001000B                                0B        FS T2/F1/M0
8003B                                     2B          29B
8003B                                     8005B       27B       8003=M
```

```
8003B                       8004B         8005B       27B       8004=2M
8160B         1B                          9B          20B       PRINT
                                                                EXIT                    +
              PHASE 3 -- PART 1 IS COMPLETE
8200B                                                 0B        LOAD+EXECUTE
1014B                                     8003B                 SKIP IF N NOT 1
              9000B                                   0B        PARTITION
8000000B                    1B                        0B        D11
1B                          1B                        18B       INVERT
1004B                                     999B
8000000B                    2B                        0B        D10
1B            2B            3B                        6B        MULTIPLY
3B                          2000000B                  0B        COPY K INV
-3B                                       8004B
              2000000B                                0B        END OF FILE
              -8000000B                               0B
              -2000000B                               0B        REW 2
1073B                                     999B        0B
8200B                                     5B          20B
              9000B                                   0B        PARTITION
              -8000000B                                         INITIAL REWINDS
              -11000000B                              0B
              -12000000B                              0B
              -11000000B
              -12000000B
8005B                                     4B          29B
8003B                       8006B         0B          27B       SAVE N FOR LOOPING
8003B                                     -1B         27B       DECREMENT N
8004B                                     -1B         27B       DECREMENT K
8000000B                    1B                        0B        PIVOT PARTITION         VT1
1B                          1B                        18B       INVERT
-1014B        -1B                         1000B       27B
8000000B                    2B                        0B        REST OF PIVOT ROW       VT2
1B            2B            3B            0B          6B        NEW PIVOT ROW
-1014B                                    100B        27B       CHANGE NAME
3B                          11000000B                 0B        ON TAPE 11
-4B                                       8004B       0B        ALL OF PIVOT ROW
              11000000B                               0B
              -11000000B                              0B
8000000B                    1B                        0B        PART. TO BE ZEROED      VT3
11000000B                   2B                        0B        PIVOT ROW
1B            2B            3B            22B         6B        MULTIPLY
3B                          2B            23B         0B        COPY
8000000B                    3B                        0B        ROW OF ZERO             VT4
3B            2B            3B            0B          2B        NEW TERM OF ROW
-1014B                                    10B         27B       CHANGE NAME
3B                          12000000B                 0B        TO TAPE 1 OR 3          VT5
-7B                                       8004B       0B        ALL TERMS OF ROW
-10B                                      8003B       0B        FOR N-1 ROWS
              -8000000B                               0B                                VT6
              -11000000B                              0B
11000000B                   1B                        0B        PIVOT ROW
1B                          12000000B                 0B        TO TAPE 3 OR 1          VT7
-2B                                       8004B       0B
              12000000B                               0B                                VT8
              -12000000B                              0B                                VT9
              -11000000B                              0B
1013B                                     8005B       0B        EVERY OTHER TIME
-1291B        -1B                         4000000B    27B       CHANGE VT1 TO 3
-1271B        -1B                         4000000B    27B       CHANGE VT2 TO 3
```

```
-1211B    -1B                 4000000B  27B       CHANGE VT3 TO 3
-1181B    -1B                 4000000B  27B       CHANGE VT4 TO 3
-1163B    -1B                 -4000000B 27B       CHANGE VT5 TO 1
-1142B    -1B                 -4000000B 27B       CHANGE VT6 TO 3
-1123B    -1B                 -4000000B 27B       CHANGE VT7 TO 1
-1112B    -1B                 -4000000B 27B       CHANGE VT8 TO 1
-1112B    -1B                 4000000B  27B       CHANGE VT9 TO 1
8005B                         1B        29B       CLEAR
8005B                         2B        27B       SET UP FOR NEXT
1011B                         255B      0B        TO END POINT
-1411B    -1B                 -4000000B 27B       CHANGE VT1 TO 1
-1391B    -1B                 -4000000B 27B       CHANGE VT2 TO 1
-1331B    -1B                 -4000000B 27B       CHANGE VT3 TO 1
-1301B    -1B                 -4000000B 27B       CHANGE VT4 TO 1
-1283B    -1B                 4000000B  27B       CHANGE VT5 TO 3
-1262B    -1B                 4000000B  27B       CHANGE VT6 TO 1
-1243B    -1B                 4000000B  27B       CHANGE VT7 TO 3
-1232B    -1B                 4000000B  27B       CHANGE VT8 TO 3
-1232B    -1B                 -4000000B 27B       CHANGE VT9 TO 3
8005B                         1B        29B       CLEAR
-52B                          8006B     0B
1002B                         8005B     0B        IF 8005=0.OUT
1011B     -1B                 -4000000B 27B
12000000B           1B                  0B        READ
1B                  2000000B            0B
-2B                           8004B     0B        NO OF COL PARTS
-3B                           8006B     0B        NO OF ROW PARTS
          2000000B                      0B        END OF FILE
          -2000000B                     0B        REW 2
          -8000000B                     0B
8160B     1B                  9B        20B       PRINT COMMENT
                                                                    +
          PHASE 3 IS COMPLETE


8000B                         100B      29B
8100B                                   0B        LOAD
          -4000000B                     0B
          -2000000B                     0B
          9000B                         0B        PARTITION
4000000B            8000B               0B        READ PARAMETERS
          -4000000B                     0B        REW 4
          2002000B                      0B        FS T7/F2/M0
8075B                         9B        19B       PRINT TITLE
2000000B            1B                  0B        READ K INV
1014B                         1B        27B       PREPARE NAME
1B                  1B        1000B     0B
1B                            8075B     20B       PRINT K INV
-4B                           8005B     0B        CYCLE M
-1034B                        -1B       27B       DECREMENT NAME
-1B                           8005B     0B
-1054B    -1B                 1000B     27B       INCREMENT NAME
-8B                           8005B     0B        CYCLE M
          -2000000B                     0B        REW 7-B1
8055B     1B                  9B        20B       COMMENT
                                                  EXIT              +

          K INV -- MATRIX NUMBER = I*1000 + J
          PRINTING OF K INV IS COMPLETE
```

```
8000B                               200B        29B         CLEAR 200 CELLS
8200B                                           0B          LOAD+EXECUTE
            -1000000B                           0B          REW 1
            -8000000B                           0B          REW 8
            -16000000B                          0B          REW 16
            -11000000B                          0B          REW 11
            9000B                               0B          PARTITION
1000000B                8000B                   0B          READ PARAMETERS
8000B                   8000000B                0B          COPY PARAMETERS
            8000000B                            0B          EOF
            1002000B                            0B          FS/F2/M0 TO READ S2
1000000B                1B                      0B          READ S2
1B                      11000000B               0B          STORE S2
-2B                                 8003B       0B          CYCLE N TIMES
            11000000B                           0B          EOF
-4B                                 8007B       0B          CYCLE J TIMES
            -11000000B                          0B          REW 11
            -1002000B                           0B          BS/F2/M0 TO READ S1
11000000B               1B                      0B          READ S2
16000000B               2B                      0B          READ K22-1*K21
1B          2B          3B                      6B          MULTIPLY
3B                      1B                      0B          COPY
1004B                               999B        0B
11000000B               2B                      0B          READ S2
16000000B               3B                      0B          READ K22-1*K21
2B          3B          1B                      30B         MULTIPLY
-3B                                 8003B       0B          CYCLE N-1 TIMES
1000000B                2B                      0B          READ S1
2B          1B          2B                      2B          SUBTRACT
2B                      8000000B                0B          STORE SR
            -11001000B                          0B          BS/F1/M0
-13B                                8005B       0B          CYCLE M TIMES
            -16000000B                          0B          REW 16
            11001000B                           0B          FS/F1/M0
-16B                                8007B       0B          CYCLE J TIMES
            8000000B                            0B          EOF
            -11000000B                          0B          REW 11
            -8000000B                           0B          REW 8
            -1000000B                           0B          REW 1
8160B       1B                      9B          20B         PRINT COMMENT
                                                            EXIT                    +

            PHASE P IS COMPLETE


8000B                               100B        29B
8100B                                           0B          LOAD
            -8000000B                           0B
            9000B                               0B          PARTITION
8000000B                8000B                   0B          READ PARAMETERS
            8001000B                            0B
8075B                               9B          19B         PRINT TITLE
8000000B                1B                      0B          READ S REDUCED
1014B                               1B          27B         PREPARE NAME
1B                      1B          1000B       0B
1B                                  8075B       20B         PRINT S REDUCED/
-4B                                 8005B       0B          CYCLE M
-1034B                              -1B         27B         DECREMENT NAME
-1B                                 8005B       0B
-1054B      -1B                     1000B       27B         INCREMENT NAME
-8B                                 8007B       0B          CYCLE J
```

```
             -8000000B                            0B        REW 8
8055B        1B                       9B          20B       COMMENT
                                                            EXIT                        +
             S RED -- MATRIX NUMBER = I*1000 + J
             PRINTING OF S RED IS COMPLETE


8000B                                 200B        29B       CLEAR 200 CELLS
8200B                                             0B        LOAD+EXECUTE
             -3000000B                            0B        REW 3
             -12000000B                           0B        REW 12
             -16000000B                           0B        REW 16
             -11000000B                           0B        REW 11
             9000B                                0B        PARTITION
3000000B                 8000B                    0B        READ PARAMETERS
8000B                    12000000B                0B        COPY PARAMETERS
             12000000B                            0B        EOF
             3002000B                             0B        FS/F2/M0 TO READ S2
3000000B                 1B                       0B        READ S2
1B                       11000000B                0B        STORE S2
-2B                                   8003B       0B        CYCLE N TIMES
             11000000B                            0B        EOF
-4B                                   8007B       0B        CYCLE J TIMES
             -11000000B                           0B        REW 11
             -3002000B                            0B        BS/F2/M0 TO READ S1
11000000B                1B                       0B        READ S2
16000000B                2B                       0B        READ K22-1*K21
1B           2B          3B                       6B        MULTIPLY
3B                       1B                       0B        COPY
1004B                                 999B        0B
11000000B                2B                       0B        READ S2
160000) 0B               3B                       0B        READ K22-1*K21
2B           3B          1B                       30B       MULTIPLY
-3B                                   8003B       0B        CYCLE N-1 TIMES
3000000B                 2B                       0B        READ S1
2B           1B          2B                       2B        SUBTRACT
2B                       12000000B                0B        STORE SR
             -11001000B                           0B        BS/F1/M0
-13B                                  8005B       0B        CYCLE M TIMES
             -16000000B                           0B        REW 16
             11001000B                            0B        FS/F1/M0
-16B                                  8007B       0B        CYCLE J TIMES
             12000000B                            0B        EOF
             -11000000B                           0B        REW 11
             -12000000B                           0B        REW 12
             -3000000B                            0B        REW 3
8160B        1B                       9B          20B       PRINT COMMENT
                                                            EXIT                        +
             PHASE B IS COMPLETE


8000B                                 100B        29B
8100B                                             0B        LOAD
             -12000000B                           0B
             9000B                                0B        PARTITION
12000000B                8000B                    0B        READ PARAMETERS
8075B                                 9B          19B       PRINT TITLE
12000000B                1B                       0B        READ S REDUCED
1014B                                 1B          27B       PREPARE NAME
1B                       1B           1000B       0B
```

```
1B                            8075B     20B       PRINT S REDUCED
-4B                           8005B     0B        CYCLE M
-1034B                        -1B       27B       DECREMENT NAME
-1B                           8005B     0B
-1054B    -1B                 1000B     27B       INCREMENT NAME
-8B                           8007B     0B        CYCLE J
          -12000000B                    0B        REW 12
8055B     1B                  9B        20B       COMMENT
                                                  EXIT                    +
          S RED -- MATRIX NUMBER = I*1000 + J
          PRINTING OF S RED IS COMPLETE


$EOF
```

APPENDIX IV

PHASE II PROGRAM LISTING

This appendix contains the following listings:

Subroutine — Page

PHASE II MAIN PROGRAM 406
- SCALE 415
- TAPOS 416
- RANLOD 418
- ARIA 422
- CONST 423
- NOISOR 424
- OUTPT 426
- PEDAN 428
- PRINTA 431
- PRINTB 433
- CONS 435
- PRINTC 436
- PRINTD 437
- DSECM1 439
- ADMIN3 441
- ADDMAT 443
- ADMIN2 445
- CQJD 449
- SUMT 451
- SUM2 453
- SECM3 454
- SECM2 457
- ADMIT3 461
- ADMIT2 463
- CQCPSD 466
- SUM3 468
- PRINTE 470
- DSECM3 472

PHASE II TLO1 SUBROUTINES 473

PHASE II PROGRAM LISTING

PHASE II – MAIN PROGRAM

```
$IBFTC PHASE2  DECK
C                *                                   *
C               *       ( P  H  A  S  E      2  )     *
C              *                                       *
C             *   R A N D O M    R E S P O N S E        *
C             *                                         *
C             *  S O L U T I O N    P R O G R A M      *
C              *                                       *
C               *                                     *
C                *          R  A  N  V  I  B         *
C
C
C     RANVIB - RANDOM VIBRATION ANALYSIS SYSTEM FOR COMPLEX STRUCTURES
C***          CALCULATES THE CROS-POWER SPECTRAL DENSITY, JOINT MOMENTS
C                        AND SPECTRAL MOMENTS.
C
C
C     *** A N A L Y S I S    O P T I O N S ***
C
C   OPTION 1         GENERAL ANALYSIS-ARBITRARY PRESSURE SPECTRA WITH
C                                      VISCOUS DAMPING.
C
C    OPTION 2         SIMPLIFIED ANALYSIS WITH CROSS TERMS-SLOWLY VARYING
C                                      PRESSURE SPECTRA, WITH DAMPING
C                                      PROPORTIONAL TO A LINEAR
C                                      COMBINATION OF INERTIA AND
C                                      STIFFNESS OR  STRUCTURAL DAMPING.
C
C    OPTION 3         SIMPLIFIED ANALYSIS WITHOUT CROSS TERMS-SLOWLY
C                                      VARYING PRESSURE SPECTRA, CROSS
C                                      TERMS DELETED. DAMPING ASSUMPTIONS
C                                      ARE SAME AS OPTION 2.
C
C
C                      FLG1=1  CALCULATE OPTION 1
C                          =2  CALCULATE OPTION 2
C                          =3  CALCULATE OPTION 3
C
C
C
C                      FLG2=1  CALCULATE JOINT DEFLECTION ( JD )
C                          =2  CALCULATE CROSS POWER SPECTRAL DENSITY -
C                               ( CPSD )
C
C
C                      FLG3=0  NO STRESSES ARE CALCULATED
C                          =1  STRESS ARE CALCULATED
C
C
C                      FLG4=0  NO SECOND MOMENTS ARE CALCULATED
C                          =1  SECOND MOMENTS ARE CALCULATED
C
C
C
C
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON /BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS,NLOOP
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4,MF,NRI
      DIMENSION IRROR(5),B(16),FREQ(25),AMASS(25),OMEGA(100)
      INTEGER FLG1,FLG2,FLG3,FLG4
      READ(5,8888) FLG1,FLG2,FLG3,FLG4,NPLATE,NBEAMS
      WRITE(6,8999)
      WRITE(6,7000)FLG1,FLG2,FLG3,FLG4,NPLATE,NBEAMS
C
C***INITIALIZE TAPES
C***NTAP1 - PHASE 1 DATA OUTPUT TAPE
C***ITAPE - PHASE 2 MASTER TAPE
C***NTAP2, NTAP3, NTAP8, NTAP11, NTAP12, NTAP15 - SCRATCH TAPES
      NTAP1 = 10
      NTAP3 = 3
      NTAP2 = 4
      NTAP8 = 8
      NTAP11 = 11
      ITAPE = 9
      NTAP12 = 12
      NTAP15 = 15
C
C***REWIND TAPES
      REWIND NTAP1
      REWIND NTAP2
      REWIND NTAP3
      REWIND NTAP8
      REWIND NTAP11
      IRELOC = 0
C
C                          ***READ NATURAL FREQUENCIES***
C
      NAME = 0
      NMAT = 0
      NFILE = 2
      CALL READTP(FREQ,1,NAME,M,1,B,NFILE,NMAT,NTAP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
C***FREQUENCIES(FREQ)          CONVERT CYCLES/SEC TO RADIANS BY MULT THE
C                              FREQ BY 2*PI,WHERE PI=3.14159265
      DO 10 I = 1,M
 10   FREQ(I) = FREQ(I)*6.2831853
C
C                          ***READ GENERALIZED MASSES***
C
      NAME = 0
      NMAT = 1
      NFILE = 0
      CALL READTP(AMASS,1,NAME,1,M,B,NFILE,NMAT,NTAP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      WRITE(6,7001)
      WRITE(6,7002)(I,FREQ(I),AMASS(I),I=1,M)
C
C***                           CARD INPUT NUMBER OF DEGREES OF FREEDOM(N)
C                                        DAMPING CONTANTS(ALAM,AMU,G)
C                                        AND OFF DIAGONAL CONSTANT K
C
      READ(5,9000) ALAM,CMU,G,N,K,NF
      WRITE(6,7003)ALAM,CMU,G,N,K,NF
C
C***  CALL SUBROUTINE TO FORWARD SPACE ON MASTER TAPE UNIT 9 TO START
C     READING THE CORRECT TL01 ROUTINES .
```

```
      CALL TAPOS
C
C
C
C***                          TEST TO SEE IF FREQUENCIES FOR THE CPSD
C                                  CALCULATIONS ARE DESIRED
      IF ( FLG2 .EQ. 2 ) GO TO 40
      IF ( FLG1 .EQ. 1 ) GO TO 40
      GO TO 50
C
C***                          READ IN THE FREQUENCIES(OMEGA)
C
 40   READ(5,9001) ( OMEGA(I),I=1,NF )
C
      WRITE(6,7004)
      WRITE(6,7005) ( I,OMEGA(I),I=1,NF )
C
C
C***                          TEST TO SEE IF OPTIONS 1,2 OR 3 IS DESIRED
C
 50   CONTINUE
C
      GO TO ( 100,378,300), FLG1
 100  CONTINUE
C
C
C
C                     *                     *
C                   *                        *
C                  *  O  P  T  I  O  N     1  *
C                   *                        *
C                     *                     *
C
C
C
C                               FLG1 = 1   CALCULATE OPTION 1
C
C***                          FORM THE EXCITATIONS CO- AND QUAD-POWER
C                                  SPECTRAL DENSITY
C
      CALL RANLOD
C
C                             FORM THE REAL AND IMAGINARY PART OF THE
C                                  MATRIX TO BE INVERTED.
C
C
C
C*SUBROUTINE PEDAN IS CALLED
      CALL PEDAN
C
C***                          FORM THE ADMITTANCE RESPONSE MATRIX
C                              (COMPLEX MATRIX INVERSION AT ALL OMEGAS)
C
C*SUBROUTINE COMINV IS CALLED
      CALL TL01( ITAPE,IRELOC,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
C
C***                          FORM THE DEFLECTION RESPONSE CPSD
C
C*SUBROUTINE CPSD1 IS CALLED
      CALL TL01( ITAPE,IRELOC,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
      CALL PRINTA
C
      IF ( FLG3 .EQ. 0 ) GO TO 110
      IF ( FLG2 .EQ. 1 ) GO TO 110
C*SUBROUTINE SRESP1 IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
      WRITE(6,9020)
      CALL PRINTB
 110  IF ( FLG2 .NE. 1 ) GO TO 1000
      NFILE = 0
      CALL FSF(NFILE,ITAPE,LERR)
C
C
C
C***                          FORM THE INTEGRATION CONSTANTS FOR THE
C                                  TRAPEZOIDAL METHOD ROUTINE
C
      CALL CONS
C
C***                          FORM THE JOINT DEFLECTION BY INTEGRATING
C                                  OVER NF FREQUENCIES-COMPLEX MATRIX
C                                  TRAPEZOIDAL INTEGRATION ROUTINE.
C
C*SUBROUTINE TRAPM IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
      CALL PRINTC
      IF ( FLG3 .EQ. 0 ) GO TO 1000
C
C***                          TEST TO SEE IF THE JOINT STRESS CPSD IS
C                                  CALCULATED
C*SUBROUTINE SJNT1 IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
C
      IF( IRROR .NE. 0 ) GO TO 9997
      WRITE(6,9010)
      NL = 2
      NFF = 1
      CALL PRINTD(NL,NTAP3,NFF)
C***                          TEST TO SEE IF THE DEFLECTION SECOND
C                                  MOMENT IS DESIRED.
      IF ( FLG4 .EQ. 0 ) GO TO 1000
      CALL DSECM1
C*SUBROUTINE SSECM IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      WRITE(6,9011)
      NL = 2
      NFF = 1
C
C***THE STRESS SECOND SPECTRAL MOMENT MATRICES ARE PRINTED IN PRINTD
      CALL PRINTD(NL,NTAP3,NFF)
      GO TO 1000
C
C
C
C
C                    *                    *
C                   *                      *
```

```
C                   * O  P  T  I  O  N     3  *
C                    *                       *
C                     *                     *
C
C
C
  300   CONTINUE
        NRI = 1
        GO TO ( 310,365 ), FLG2
C***                                CALCULATE JOINT DEFLECTION-OPTION 3
C
C***                                CALC THE CO-PSD ONLY
C
  310   CALL RANLOD
C***                                CALC THE ADMITTANCE INTEGRAL SCALARS
        CALL ADMIN3
C***                                CALC THE JOINT DEFLECTIONS
C*SUBROUTINE DJNT3 IS CALLED
        CALL TL01( ITAPE,IRELOC,IRROR )
        IF( IRROR .NE. 0 ) GO TO 9997
C***                                SUM THE JOINT DEFLECTIONS AT LIKE MODES
        NO = 1
        MF = M
        CALL ADDMAT(NTAP8,NTAP3,NO)
C***                                TEST TO SEE IF THE STRESS IS DESIRED
        IF ( FLG3 .EQ. 0 ) GO TO 1000
C***                                    CALCULATE THE STRESSES
C*SUBROUTINE SJNT3 IS CALLED
        CALL TL01( ITAPE,IRELOC,IRROR )
        IF( IRROR .NE. 0 ) GO TO 9997
        WRITE(6,9012)
        NL = 1
        NFF = 1
        CALL PRINTD(NL,NTAP15,NFF)
C
C***                                TEST TO SEE IF THE DEFLECTION SECOND
C                                       MOMENTS ARE DESIRED
        IF ( FLG4 .EQ. 0 ) GO TO 1000
C***                                CALCULATE THE DEFLECTION SECOND MOMENTS
C
C***                                CALC THE SECOND MOM ADMITTANCE INTEGRAL
C                                       SCALARS
C
C***                                CALC THE DEFLECTION SECOND MOMENTS
C
        CALL DSECM3
C***                                CALCULATE THE DEFLECTION JOINT STRESS
C* SUBROUTINE DSJNT3 IS CALLED
        CALL TL01( ITAPE,IRELOC,IRROR )
        IF ( IRROR .NE. 0 ) GO TO 9997
        WRITE(6,9013)
        NL = 1
        NFF = 1
        CALL PRINTD(NL,NTAP15,NFF)
        GO TO 1000
C***                             *** OPTION 3-DEFLECTION CPSD ***
  365   CONTINUE
C***                                FORM THE CO- AND QUAD-PSD AT NF FREQ.
        CALL RANLOD
C***                                FORM THE ADMITTANCE SCALARS-OPTION 3
```

```
      CALL ADMIT3
C***                          FORM THE DEFLECTION RESPONSE PSD
C*SUBROUTINE CPSD3 IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
C***                          SUM THE DEFLECTION RESPONSE CPSD FOR
C                                 ALL LIKE MODES.
      MF = M
      CALL ADDMAT(NTAP8,NTAP3,NF)
      IF ( FLG3 .EQ. 0 ) GO TO 1000
C***                          CALCULATE THE STRESS RESPONSE PSD
C*SUBROUTINE SRESP3 IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
      WRITE(6,9014)
      NL = 1
      NFF = NF
      CALL PRINTD(NL,NTAP15,NFF)
      GO TO 1000
 378  CONTINUE
C
C
C
C                    *                     *
C                   *                       *
C                  * O  P  T  I  O  N     2  *
C                   *                       *
C                    *                     *
C
C
C
C                         *** OPTION 2-JOINT DEFLECTIONS ***
C
      NLOOP = (M-1)*K - K*(K-1)/2
C                             FORM THE CO- AND QUAD-PSD
      GO TO ( 380,400 ), FLG2
 380  CALL RANLOD
      CALL ADMIN3
      CALL TLO1(ITAPE,IRELOC,IRROR)
      IF ( IRROR .NE. 0 ) GO TO 9997
      NRI = 1
      NO = 1
      MF = M
      CALL ADDMAT(NTAP8,NTAP3,NO)
C***                          FORM THE ADMITTANCE INTEGRAL SCALARS
      CALL ADMIN2
C***                          CALCULATE THE EXCITATIONS
      CALL CQJD
C***                          FORM THE JOINT DEFLECTION CPSD
C*SUBROUTINE DJNT2 IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
C***                          SUM THE JOINT DEFLECTIONS WITH ALL CROSS
C                                 MODES INCLUDED WITH LIKE MODE EFFECTS.
      NRI = 2
      NO = 1
      MF = M-1
      CALL ADDMAT(NTAP8,NTAP2,NO)
      NO = 1
      CALL SUMT(NO,NTAP2)
```

```
C***                          SUM OPTION 2 EFFECT TO OPTION 3
      NO = 2
      NCN = 1
      CALL SUM2(NTAP3,NTAP2,NO,NCN)
C***                          TEST TO SEE IF THE SECOND MOMENT SCALARS
C                                  IN THE FATIGUE LIFE CALC ARE TO BE
C                                  COMPUTED.
      IF ( FLG3 .EQ. 0 ) GO TO 1000
C*SUBROUTINE SJNT2 IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      IF ( IRROR .NE. 0 ) GO TO 9997
      WRITE(6,9015)
      NL = 2
      NFF = 1
      CALL PRINTD(NL,NTAP15,NFF)
      IF ( FLG4 .EQ. 0 ) GO TO 1000
      CALL SECM3
      CALL TLO1(ITAPE,IRELOC,IRROR)
      IF ( IRROR .NE. 0 ) GO TO 9997
      NRI = 1
      NO = 1
      MF = M
      CALL ADDMAT(NTAP8,NTAP3,NO)
C
C***                          FORM THE SEC MOM ADM INT SCALARS
      CALL SECM2
C***                          CALCULATE THE EXCITATIONS
      CALL CQJD
C***                          FORM THE DEFLECTION SECOND MOMENTS
C*SUBROUTINE DSECM2 IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
      NRI = 2
      NO = 1
      MF = M-1
      CALL ADDMAT(NTAP8,NTAP2,NO)
      NO = 1
      CALL SUMT(NO,NTAP2)
      NO = 2
      NCN = 2
      CALL SUM2(NTAP3,NTAP2,NO,NCN)
C
C*SUBROUTINE SECM2 IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      IF ( IRROR .NE. 0 ) GO TO 9997
      WRITE(6,9016)
      NL = 2
      NFF = 1
      CALL PRINTD(NL,NTAP15,NFF)
      GO TO 1000
 400  CONTINUE
C                         *** OPTION 2-CPSD ***
C***                          CALC THE CO- AND QUAD-(PSD OPTION 2)
      CALL RANLOD
      CALL ADMIT3
      CALL TLO1(ITAPE,IRELOC,IRROR)
      IF ( IRROR .NE. 0 ) GO TO 9997
      NRI = 1
      MF = M
      CALL ADDMAT(NTAP8,NTAP3,NF)
```

```
C***                     FORM THE ADMITTANCE SCALARS
      CALL ADMIT2
C***                     CALC THE EXCITATIONS FOR OPTION 2-CPSD
      CALL CQCPSD
C***                     CALC THE DEFLECTION RESPONSE CPSD
C*SUBROUTINE DRESP2 IS CALLED
      CALL TLO1( ITAPE,IREL-C,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
C***                     SUM OVER ALL CROSS-MODE EFFECTS
      NRI = 1
      NO = 2*NF
      MF = M-1
      CALL ADDMAT(NTAP8,NTAP2,NO)
      NO = NF
      CALL SUMT(NO,NTAP2)
C***                     SUM THE CROSS-MODE EFFECTS TO OPTION 3
C                           LIKE MODES TO GET THE TOTAL DEFLECTION
C                           RESPONSE CPSD
      WRITE(6,9018)
      CALL SUM3(NTAP3,NTAP2,NTAP8)
C
C
C***                     TEST TO SEE IF THE STRESSES ARE DESIRED
      IF ( FLG3 .EQ. 0 ) GO TO 1000
C***                     CALCULATE THE STRESS RESPONSE CPSD
C*SUBROUTINE SRESP2 IS CALLED
      CALL TLO1( ITAPE,IRELOC,IRROR )
      IF( IRROR .NE. 0 ) GO TO 9997
      WRITE(6,9017)
      CALL PRINTE
C
      GO TO 1000
 9985 WRITE(6,9990) IRR
      RETURN
 9997 WRITE(6,9998)
      WRITE(6,9999) IRROR
 1000 CONTINUE
      WRITE(6,9019)
      CALL UNLOAD(NTAP1)
      RETURN
 7000 FORMAT(1H0,16HOPTION CONTROLS 7HFLAG 1=I2,5X,7HFLAG 2=I2,5X,
     17HFLAG 3=I2,5X,7HFLAG 4=I2,5X,7HNPLATE=I4,5X,7HNBEAMS=I4///)
 7001 FORMAT(10X,32HNATURAL FREQUENCIES(RADIANS/SEC),10X,18HGENERALIZED
     1MASSES//)
 7002 FORMAT(20X,I5,5X,E14.7,10X,E14.7)
 7003 FORMAT(1H0,7HLAMBDA=F12.6,5X,3HMU=F12.6,5X,2HG=F12.6,5X,2HN=I5,
     15X,2HK=I5,5X,3HNF=I5////)
 7004 FORMAT(1H1,31HCROSS-PSD FREQUENCIES(RAD/SEC) ///)
 7005 FORMAT(1X,I5,5X,E14.7)
 8888 FORMAT(6I10)
 8999 FORMAT(1H1,25X,74HRANDOM VIBRATION ANALYSIS SYSTEM FOR COMPLEX STR
     1UCTURES (  R A N V I B  )  //// )
 9000 FORMAT( 3F10.0,3I10 )
 9001 FORMAT(7F10.0)
 9010 FORMAT(1H1,40X,26HSTRESS COVARIANCE MATRICES ////)
 9011 FORMAT(1H1,40X,38HSTRESS SECOND SPECTRAL MOMENT MATRICES ////)
 9012 FORMAT(1H1,40X,38HSTRESS COVARIANCE MATRICES (REAL PART)  ///)
 9013 FORMAT(1H1,40X,49HSTRESS SECOND SPECTRAL MOMENT MATRIX (REAL PART)
     1   ////)
 9014 FORMAT(1H1,40X,25HSTRESS CROSS PSD MATRICES   ///)
```

```
9015 FORMAT(1H1,40X,26HSTRESS COVARIANCE MATRICES ////)
9016 FORMAT(1H1,40X,39HSTRESS SECOND SPECTRAL MOMENT MATRICES ////)
9017 FORMAT(1H1,40X,25HSTRESS CROSS-PSD MATRICES ////)
9018 FORMAT(1H1,40X,30HDEFLECTION CROSS PSD MATRICES  ////)
9019 FORMAT(1H0,30X,58H R A N V I B   P R O G R A M   I S   C O M P
    1L E T E D  )
9020 FORMAT(1H1,40X,25HSTRESS CROSS-PSD MATRICES ////)
9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
9998 FORMAT(104H 5 INSTRUCTION FIELDS OF THE CARD THAT TL01 WAS TRYING
    1TO INTERPRET AT THE TIME AN ERROR WAS ENCOUNTERED )
9999 FORMAT( 5(5X,I10) )
     END
```

SUBROUTINE SCALE

```
$IBFTC SCALE*  DECK
      SUBROUTINE SCALE(FREQ,NFREQ,SCAL)
C***  SUBROUTINE TO CALCULATE THE ADMITTANCE INTEGRAL SCALE FACTOR
C     AND SCALE THE FREQUENCIES
C***  FREQ-THE SCALED FREQUENCIES
C***  NFREQ-NO OF FREQUENCIES
C***  SCALE-THE SCALE FACTOR
C   SCAL         SCALING FACTOR, DETERMINED BY EXAMINING THE MAGNITUDE
C                OF THE FIRST NATURAL FREQUENCY.  THIS ROUTINE WILL ONLY
C                SCALE FREQUENCIES IN THE RANGE OF ( 0 TO 100,000 ). AFTER
C                THE SCALING FACTOR IS FOUND ALL FREQ. WILL BE SCALED.
C           ****(FREQUENCY RANGE)* * * * * * * * * * * * * * *SCALE FACTOR
C                   0 TO 100 INCLUSIVE                                10
C            GREATER THAN 100 AND LESS THAN OR EQUAL TO 1,000         100
C            GREATER THAN 1,000 AND LESS THAN OR EQ TO 10,000         1,000
C            GREATER THAN 10,000 AND LESS THAN OR EQ TO 100,000       10,000
C
C
C                AFTER THE QUOTIENT HAS BEEN FOUND THE RESULT IS DIVIDED
C                BY THE SCALE FACTOR CUBED TO OBTAIN THE CORRECT RESULTS.
C                THIS ROUTINE WILL SCALE THE FREQUENCIES.  THERE WILL BE
C                AN OVERFLOW IN THE CALCULATIONS OF THE ADMITTANCE
C                INTEGRALS IF THE FREQUENCIES ARE NOT SCALED.
C
C
      DIMENSION FREQ(1)
      DO 100 I=2,5
      P=10**I
      IF(FREQ(1)-P)20,20,100
 20   SCAL = P/10.
      GO TO 200
 100  CONTINUE
 200  DO 300 I=1,NFREQ
 300  FREQ(I) = FREQ(I)/SCAL
      RETURN
      END
```

SUBROUTINE TAPOS

```
$IBFTC TAPOS*  DECK
      SUBROUTINE TAPOS
      COMMON /BLK3/FLG1,FLG2,FLG3,FLG4
      INTEGER FLG1, FLG2, FLG3, FLG4
C
C
C            SUBROUTINE TO POSITION TO THE START OF THE TL01 ROUTINES
C          ON THE MASTER TAPE UNIT 9 FOR THE JOINT DEFLECTIONS AND
C          CROSS POWER SPECTRAL DENSITY CALCULATIONS FOR OPTIONS 1, 2,
C          AND 3 .
C
C
C                    FLG1 = 1    OPTION 1
C                         = 2    OPTION 2
C                         = 3    OPTION 3
C
C
C                    FLG2 = 1    JOINT DEFLECTIONS
C                         = 2    CROSS PSD
C
C
C                    FLG3 = 0    NO STRESSES
C                         = 1    STRESSES
C
C
C                    FLG4 = 0    NO DEFLECTION SECOND MOMENTS
C                         = 1    DEFLECTION SECOND MOMENTS
C
C
C          ROUTINE FSF IS USED TO DO THE FORWARD SPACING OF THE NUMBER
C          OF FILE MARKS .
C
C
C
      ITAPE = 9
      GO TO ( 100, 200, 300 ), FLG1
C
C***  O P T I O N   1
C
 100  GO TO ( 10, 20 ), FLG2
 10   NFILE = 5
      GO TO 500
 20   NFILE = 5
      GO TO 500
C
C***  O P T I O N   2
C
 200  GO TO ( 210, 220 ), FLG2
 210  NFILE = 3
      GO TO 500
 220  NFILE = 4
      GO TO 500
C
C
C***  O P T I O N   3
C
 300  GO TO ( 310, 320 ), FLG2
```

```
310  NFILE = 1
     GO TO 500
320  NFILE = 2
500  CALL FSF ( NFILE, ITAPE, LERR )
     RETURN
     END
```

SUBROUTINE RANLOD

```
$IBFTC RANLO*  DECK
      SUBROUTINE  RANLOD
C              FORCE CROSS POWER SPECTRAL DENSITY GENERATION PROGRAM
C
C         DEFINITION OF OPTION FLAGS IN COMMON BLK3
C              FLG1 = 1  SOLUTION OPTION 1
C                   = 2  SOLUTION OPTION 2
C                   = 3  SOLUTION OPTION 3
C              FLG2 = 1  JOINT DEFLECTIONS
C                   = 2  CPSD
C              FLG3 AND FLG4 ARE NOT USED IN THIS PROGRAM
C         MISCELLANEOUS
C              NFREQ =  NO. OF NATURAL FREQUENCIES
C              NRTNDS=  NO. OF D.O.F. (RETAINED NODES)
C              KDIG = NO. OFF DIAGONAL TERMS DESIRED
C              NF =  NO. OF SELECTED CPSD FREQUENCIES
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/NFREQ,NSIZE ,G,ALAM,CM,KDIG,NF
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4
      COMMON/BLK4/IT5,IT6,ITAPE,JTAPE,IFILE,IMAT,IRR,NAME,NDIM,C
      COMMON/BLK5/N1,N2,CRD1,CRD2,AREA,IPT
      COMMON/BLK6/PHI,CF,QF
      INTEGER FLG1,FLG2,FLG3,FLG4
      DIMENSION FREQ(25),AMASS(25),OMEGA(100)
C
      DIMENSION IPT(4),CRD1(100),CRD2(100),AREA(100),PHI(100)
      DIMENSION CF(85,85),QF(85,85),C(12)
      DIMENSION TITLE(14)
C************************ TAPE AND I/O INITIALIZATION SECTION **********
      I3FLG = 0
      IT5 = 5
      IT6 = 6
      ITAPE = 17
      JTAPE = 14
      IFG = FLG2
      IF ( FLG1 .EQ. 1 ) FLG2 = 2
C
      IFILE = 0
      IMAT = 0
      IRR = 0
      NAME = 0
      NDIM = 85
C******   SPECIAL HANDLING IS REQUIRED FOR OPT. 2
C         ASK QUESTION - IS THIS OPTION 2
      IF (FLG1.NE.2) GO TO 19
C
      I3FLG = 2
      FLG1 =  3
C*****    OPTION 3 IS DONE FIRST, THEN OPTION 2 ,DIFFERENT TAPE
C         SETUP REQUIRED FOR J.D. AND CPSD
 19   IF (FLG1-1) 40,40,20
 20   IF (FLG1-2)  30,30,40
 30   REWIND JTAPE
      IF (FLG2-1)  40,40,50
 40   REWIND ITAPE
 50   IF (I3FLG-2) 55,55,53
 53   IF (FLG2-2) 80,210,210
 55   READ(IT5,1000) TITLE
C
C************************ INPUT DATA SECTION ***************************
C
      READ(IT5,1001) (IPT(I),I=1,4)
      READ(IT5,1002) D,CX,CY
      READ(IT5,1001) N1,N2
      READ(IT5,1002) (CRD1(I),I=1,N1)
      READ(IT5,1002) (CRD2(I),I=1,N2)
      IT= IPT(1)
      GO TO (60,70), IT
C
C     READ AREAS
C
 60   READ(IT5,1002) (AREA(I),I=1,NSIZE)
      GO TO 80
C
C     CALCULATE  AREAS
C
 70   CALL ARIA
C
C     COMPUTE NO. OF FREQS FOR LIMIT ON READING PHI,S
C
 80   GO TO (100,90), FLG2
C
C     CPSD SOLUTION-NO. OF FREQUENCIES EQUAL  NF
C
 90   ILIM  = NF
      GO TO 130
C
C     JOINT DEFLECTION SOLUTION
C
 100  GO TO (110,110,120),FLG1
C
 110  ILIM =  (NFREQ-1)*KDIG -  (KDIG*(KDIG-1))/2
      GO TO 130
 120  ILIM = NFREQ
C
 130  READ(IT5,1002) (PHI(I),I=1,ILIM)
      IF (I3FLG - 2)  131,131,135
C
C
C*****M****************** PRINT INPUT SECTION **************************
  131 WRITE(IT6,2000)
      WRITE(IT6,2001)
      WRITE(IT6,2002) TITLE
      WRITE(IT6,2003)
      WRITE(IT6,2004)(IPT(I),I=1,4)
      WRITE(IT6,2005)D,CX,CY
      WRITE(IT6,2006) N1,N2
      WRITE(IT6,2007)
      WRITE(IT6,2008)(CRD1(I),I=1,N1)
      WRITE(IT6,2009)
      WRITE(IT6,2008) (CRD2(I),I=1,N2)
      WRITE(IT6,2010)
      WRITE(IT6,2008)(AREA(I),I=1,NSIZE)
 135  WRITE(IT6,2011)
      WRITE(IT6,2008) (PHI(I),I=1,ILIM)
C************************ CALCULATE CT AND THETA  **********************
C                         FOR PROGRESSIVE WAVE
```

```
C
      IF(I3FLG-2) 136,136,134
  134 WRITE(IT6,2014)
      GO TO 210
 136  IF (IPT(2)-1) 160,160,140
 140  CALL CONST(CX,CY,CT,THETA)
      WRITE(IT6,2012)
      WRITE(IT6,2013) CT,THETA
C     REARRANGE COORDINATES FOR SEPERATION CALCULATION IN NOISOR
C
 160  DO 170 I=1,N1
      CRD1(I)=CRD1(I+1)
 170  CONTINUE
      DO 180 I=1,N2
      CRD2(I)=CRD2(I+1)
 180  CONTINUE
      N1 = N1 - 2
      N2 = N2 - 2
C
C     ASSURE THE FREQUENCIES ARE STORED IN OMEGA
C
      IF(FLG2-1)  190,190,210
 190  DO 200 I=1,NFREQ
      OMEGA(I)= FREQ(I)
 200  CONTINUE
C
C     SET UP TO CALL GENERATION ROUTINE - NOISOR
C
C     IS THIS A JOINT DEFLECTION OPTION 2 SOLUTION
 210  GO TO(220,240), FLG2
C     YES - JOINT DEFLECTION
 220  GO TO(240,230,250), FLG1
C
C     YES - OPTION 2
 230  ILIM = NFREQ - 1
      KLIM = 0
      GO TO 260
 240  KLIM = NF
      ILIM = 1
      GO TO 260
 250  ILIM = 1
      KLIM = NFREQ
C
 260  WRITE (IT6,2016)
      CALL NOISOR(ILIM,KLIM,D,CT,THETA,CX,CY)
C
C***************************** CLOSE OFF TAPES *************************
C
      GO TO (280, 270, 280),FLG1
 270  END FILE JTAPE
      REWIND JTAPE
      GO TO (280,290), FLG2
 280  END FILE ITAPE
      REWIND ITAPE
  290 IF (I3FLG-2)320,310,320
C
C******   IF THIS IS AN OPT 2 SOLUTION, THE PROGRAM MUST BE RECYCLED
 310  FLG1 = 2
      ITAPE  = 2
      I3FLG = 3
      GO TO 19
 320  IF ( FLG1 .EQ. 1 ) FLG2 = IFG
      WRITE(IT6,2015)
      RETURN
C
C************************ I N P U T   F O R M A T S *********************
C
 1000 FORMAT(14A6)
 1001 FORMAT(7I10)
 1002 FORMAT(7F10.0)
C************************ O U T P U T   F O R M A T S *******************
C
 2000 FORMAT(1H1,50X,28HRANDOM LOADING MODULE OUTPUT///)
 2001 FORMAT(1H0,86HFORCE CROSS POWER SPECTRAL DENSITY FOR DECAYED PROGR
     1ESSIVE WAVES FOR USE WITH PANEL - )
 2002 FORMAT(1H ,14A6///)
 2003 FORMAT(1H0,55X,18HI N P U T   D A T A//)
 2004 FORMAT(1H0,104HTHE FOLLOWING FOUR OPTIONS HAVE BEEN SELECTED (THEY
     1 APPEAR IN THE ORDER IN WHICH THEY WERE CARD INPUT) -//1X,16HOPTIO
     2N(S) (1) = ,I2, 8H   (2) = ,I2,8H   (3) = ,I2,8H   (4) = ,I2/)
 2005 FORMAT(1H0,28HPARAMETER VALUES ARE - D   = ,E15.8/24X, 5HCX = ,E15.
     18/24X, 5HCY = ,E15.8/)
 2006 FORMAT(1H0, 66HNUMBER OF COORDINATES IN THE DIRECTION OF CYCLIC NO
     1DE NUMBERING - ,I3/1X, 94HNUMBER OF COORDINATES IN THE DIRECTION -
     2ERPENDICULAR.TO THE CYCLIC NODE NUMBERING DIRECTION - ,I3/)
 2007 FORMAT(1H0, 60HORIGIN-TO-NODE LINE DISTANCES IN THE CYCLIC DIRECTI
     1ON ARE - )
 2008 FORMAT(1H0,6E16.7/(E17.7,5E16.7))
 2009 FORMAT(1H0, 74HORIGIN-TO-NODE LINE DISTANCES PERPENDICULAR TO THE
     1CYCLIC DIRECTION ARE - )
 2010 FORMAT(1H0,42HAREA ASSOCIATED WITH EACH RETAINED NODE - )
 2011 FORMAT(1H0,40HPRESSURE POWER SPECTRAL DENSITIES ARE - )
 2012 FORMAT(//1H0,28H*****COMPUTED CONSTANTS*****)
 2013 FORMAT(1H0,38HTRACE VELOCITY OF PRESSURE WAVE, CT = ,E15.8/1X,66HA
     1NGLE BETWEEN TRACE WAVE PROPAGATION DIRECTION AND X-AXIS, THETA =
     2,E15.8)
 2014 FORMAT(///1H0,102H***** THIS IS AN OPTION 2 SOLUTION - RESULTS OF
     1OPTION 3 APPEAR ABOVE FOLLOWED BY OPTION 2 BELOW ***** )
 2015 FORMAT(1H0, 29H**** GENERATION COMPLETE ****)
 2016 FORMAT(1H0,75HTHE FOLLOWING FORCE CROSS POWER SPECTRAL DENSITY MAT
     1RICES WERE GENERATED - )
      END
```

SUBROUTINE ARIA

```
$IBFTC ARIA**  DECK
      SUBROUTINE ARIA
C         THIS ROUTINE CALCULATES THE NODAL AREAS FOR THE RETAINED
C         NODES IN A RECTANGULAR PANEL CONFIGURATION. THE GRID CAN
C         HAVE UNEQUALLY SPACED COORDINATES IN EITHER OR BOTH THE
C         X AND Y DIRECTION. THE COORDINATE ORIGIN CAN BE (0,0) OR
C         (X0,Y0).
C
C                     DESCRIPTION OF CALLING SEQUENCE
C         1.    X-ARRAY  THE SET OF X-COORDINATES FOR THE RETAINED
C                CRD1    NODES, WHERE X(1) AND X(LAST) ARE THE
C                        BOUNDARY VALUES -INPUT
C         2.    Y-ARRAY  THE SET OF Y-COORDINATES CORRESPONDING -INPUT
C                CRD2    WITH X - INPUT
C         3.    NX-N1    THE NUMBER OF RETAINED NODES IN THE X-DIRECTION
C         4.    NY-N2    THE NUMBER OF RETAINED NODES IN THE Y-DIRECTION
C         5.    AREA     THE SET OF AREAS FOR RETAINED NODES - OUTPUT
C
C     L IS A COUNTER   L=1,NO. OF RETAINED NODES = NX*NY
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/NFREQ,NSIZE ,G,ALAM,CM,KDIG,NF
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4
      COMMON/BLK4/IT5,IT6,ITAPE,JTAPE,IFILE,IMAT,IRR,NAME,NDIM,C
      COMMON/BLK5/N1,N2,CRD1,CRD2,AREA,IPT
      COMMON/BLK6/PHI,CF,QF
      INTEGER FLG1,FLG2,FLG3,FLG4
      DIMENSION FREQ(25),AMASS(25),OMEGA(100)
C
      DIMENSION IPT(4),CRD1(100),CRD2(100),AREA(100),PHI(100)
      DIMENSION CF(85,85),QF(85,85),C(12)
      L = 0
      M = N1 - 1
      N = N2 - 1
C
      DO 100 I=2,N
C
      DELY = (CRD2(I+1)- CRD2(I-1))/4.0
      DO 100 J= 2,M
C
      L = L + 1
C
      AREA(L) =(CRD1(J+1)- CRD1(J-1))*DELY
  100 CONTINUE
      RETURN
      E-D
```

SUBROUTINE CONST

```
$IBFTC CONST*  DECK
      SUBROUTINE CONST(CX,CY,CT,THETA)
C         THIS ROUTINE CALCULATES THE TRACE VELOCITY (CT) AND
C         THETA - THE ANGLE BETWEEN DIRECTION OF SOUND PROPAGATION
C         AND X AND Y AXIS OF PANEL IN THE CASE OF A PROGRESSIVE
C         WAVE.CX IS THE PHASE VELOCITY ALONG PANEL IN X-DIRECTION
C         CY IN Y-DIRECTION.
C         CALCULATE CT.
C
      IF (CX) 20,10,20
C
 10   CT = CY
      THETA = 1.57079
      GO TO 100
 20   IF (CY) 40,30,40
C
 30   CT = CX
      THETA = 0.0
      GO TO 100
 40   THETA = ASIN(  1.0/(SQRT(1.0 + (CY/CX)**2)))
      IF (THETA - 0.2)  50,50,60
C
 50   CT = CX*COS(THETA)
      GO TO 100
C
 60   CT = CY*SIN(THETA)
 100  RETURN
      END
```

SUBROUTINE NOISOR

```
$IBFTC NOISO*  DECK
      SUBROUTINE NOISOR(ILIM,KLIM,D,CT,THETA,CX,CY)
C           SUBROUTINE NOISOR SIMULATES TWO DIFFERENT NOISE SOURCE
C           CONDITIONS. (1) NORMAL INCIDENCE WAVES - OCCURS WHEN THE
C           TRAIN OF WAVE FRONTS ARE PARLLEL TO THE PANEL.
C                       (2) PROGRESSIVE WAVE - OCCURS WHEN THE TRAIN
C           OF INCIDENT PLANE WAVE FRONTS ARE NOT PARALLEL TO THE
C           PANEL FACE.
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/NFREQ,NSIZE ,G,ALAM,CM,KDIG,NF
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4
      COMMON/BLK4/IT5,IT6,ITAPE,JTAPE,IFILE,IMAT,IRR,NAME,NDIM,C
      COMMON/BLK5/N1,N2,CRD1,CRD2,AREA,IPT
      COMMON/BLK6/PHI,CF,QF
      INTEGER FLG1,FLG2,FLG3,FLG4
      DIMENSION FREQ(25),AMASS(25),OMEGA(100)
C
      DIMENSION IPT(4),CRD1(100),CRD2(100),AREA(100),PHI(100)
      DIMENSION CF(85,85),QF(85,85),C(12)
      CSTHET = COS(THETA)
      SNTHET = SIN(THETA)
      IF (CX) 1,2,2
 1    CSTHET = -COS(THETA)
 2    IF (CY) 3,4,4
 3    SNTHET = -SIN(THETA)
 4    IF (IPT(4)-1) 5,5,6
 5    DUM = SNTHET
      SNTHET = CSTHET
      CSTHET = DUM
 6    NPHI = 0
      DO 600 L=1,ILIM
      IF (ILIM-1) 20,20,10
C     IF ILIM = 1, THEN THIS IS NOT  JOINT DEFLECTION OPT 2 .
C
C     JOINT DEFL. OPT. 2
 10   LL = L + 1
      KLIM =  L + KDIG
      IF(KLIM.GT.NFREQ) KLIM=NFREQ
      GO TO 30
C     OUTER  LOOP = 1
 20   LL = 1
 30   DO 500 K = LL,KLIM
      NPHI = NPHI + 1
      OMEGL = OMEGA(L)
      IF (ILIM-1)  50,50,40
 40   OMCT = (OMEGL + OMEGA(K))/2.0
      GO TO 60
 50   OMCT = OMEGA(K)
 60   PHIO = PHI(NPHI)
      OMG = OMCT
      OMCT = OMCT/CT
C     BEGIN  ELEMENT BY ELEMENT MATRIX GENERATION - FORMED IN THE
C     UPPER TRIANGULAR AND TLACE IN THE LOWER
      DO 400 += 1,NSIZE
      ARI = AREA(I)
      DO 300 J=I,NSIZE
      AR = ARI*AREA(J)
```

```
C*****M***********************SEPARATION CALCULATION********************
      N1J   = MOD(J,N1)
      N1I   = MOD(I,N1)
      IF (N1J)  80,70,80
 70   N2J   = J/N1
      N1J = N1
      GO TO 90
 80   N2J =J/N1 + 1
 90   IF (N1I)  110,100,110
 100  N2I   = I/N1
      N1I   = N1
      GO TO 120
 110  N2I   = I/N1 + 1
 120  SEP2 = CRD2(N2J) - CRD2(N2I)
      SEP1 = CRD1(N1J) - CRD1(N1I)
C***********************************************************************
C     CHECK IF A DIAGONAL ELEMENT
      IF (I - J) 150,130,150
C
 130  CF(I,J)= AR*PHIO
C     CHECK  IF  QF(I,J) IS NEEDED
      IF (FLG1-3) 140,300,140
 140  QF(I,J)= 0.0
      GO TO 300
 150  EXYSQ = SQRT(SEP1**2 + SEP2**2)
      EXPON = EXP(-D*EXYSQ)
C     CHECK IF NORMAL INCIDENCE OR PROGRESSIVE WAVE
 160  IF (IPT(2)-1)  180,170,180
C     NORMAL INCIDENCE
 170  CP2= 1.0
      GO TO 190
C     PROGRESSIVE WAVE
 180  P2 = OMCT*(SEP1*CSTHET + SEP2*SNTHET)
      CP2 = COS(P2)
 190  CF(I,J) = AR*PHIO*EXPON*CP2
      CF(J,I) = CF(I,J)
C     CHECK IF QF(I,J)  IS NEEDED
      IF (FLG1 - 3)  200,300,200
C     CHECK IF NORMAL INCIDENCE  OR PROGRESSIVE WAVE
 200  IF (IPT(2)-1)  220,210,220
C     NORMAL INCIDENCE
 210  QF(I,J)= 0.0
      QF(J,I)= QF(I,J)
      GO TO 300
C     PROGRESSIVE WAVE
 220  QP2 = SIN(P2)
      QF(I,J) = AR*PHIO*EXPON*QP2
      QF(J,I) = -QF(I,J)
C
 300  CONTINUE
 400  CONTINUE
      CALL OUTPUT(NPHI,OMG)
 500  CONTINUE
 600  CONTINUE
      RETURN
      END
```

SUBROUTINE OUTPT

```
$IBFTC OUTPUT  DECK
      SUBROUTINE OUTPT(NPHI,OMG)
C         THIS SUBROUTINE HANDLES THE OUTPUT FOR EACH FREQUENY,
C         BOTH THE PRINTED OUTPUT AND THE BINARY TAPES.
C         NPHI IS THE CURRENT FREQUENCY NUMBER
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/NFREQ,NSIZE ,G,ALAM,CM,KDIG,NF
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4
      COMMON/BLK4/IT5,IT6,ITAPE,JTAPE,IFILE,IMAT,IRR,NAME,NDIM,C
      COMMON/BLK5/N1,N2,CRD1,CRD2,AREA,IPT
      COMMON/BLK6/PHI,CF,QF
      INTEGER FLG1,FLG2,FLG3,FLG4
      DIMENSION FREQ(25),AMASS(25),OMEGA(100)
C
      DIMENSION IPT(4),CRD1(100),CRD2(100),AREA(100),PHI(100)
      DIMENSION CF(85,85),QF(85,85),C(12)
C***********************PRINT SECTION**********************************
C
      IF (IPT(3)-NPHI)  200,10,10
C
 10   WRITE(IT6,2000) NPHI, OMG
C
C     PRINT CF(OMEGA(NPHI))
C
      DO 20 IROW=1,NSIZE
      WRITE(IT6,2001) IROW,(CF(IROW,J),J=1,NSIZE)
 20   CONTINUE
C
C     TEST IF QF(OMEGA) IS NEEDED-IE YES IF EITHER OPTION 1 OR 2
      IF(FLG1-2)  30,30,200
C
 30   WRITE(IT6,2002) NPHI, OMG
C
C     PRINT QF(OMEGA(NPHI))
C
      DO 40 IROW =1,NSIZE
      WRITE(IT6,2001) IROW,(QF(IROW,J),J=1,NSIZE)
 40   CONTINUE
C***********************TAPE GENERATION SECTION***********************
C
C     FIRST DETERMINE WHETHER JOINT DEFLECTIONS OR CPSD
C
 200  IF(FLG2-1)  210,210, 300
C
C******** JOINT DEFLECTIONS
C
C     TEST FOR OPTION  2 OR 3
C
 210  IF (FLG1-2)  220,220,250
C
C***** OPTION 2
C
 220  IFILE = 0
      IMAT = 0
      CALL WRTETP(CF,NDIM,NAME,NSIZE,NSIZE,C,IFILE,IMAT,ITAPE,IRR)
      CALL WRTETP(QF,NDIM,NAME,NSIZE,NSIZE,C,IFILE,IMAT,JTAPE,IRR)
      GO TO 500
```

```
C***** OPTION 3
  250 CALL WRTETP(CF,NDIM,NAME,NSIZE,NSIZE,C,IFILE,IMAT,ITAPE,IRR)
      GO TO 500
C
C******** CPSD
C
C     TEST FOR OPTION 1,2,OR 3
C
  300 GO TO (310,330,350), FLG1
C
C***** OPTION 1
C
  310 END FILE ITAPE
      CALL WRTETP(QF,NDIM,NAME,NSIZE,NSIZE,C,IFILE,IMAT,ITAPE,IRR)
      CALL WRTETP(CF,NDIM,NAME,NSIZE,NSIZE,C,IFILE,IMAT,ITAPE,IRR)
      GO TO 500
C
C***** OPTION 2
C
  330 END FILE JTAPE
      CALL WRTETP(CF,NDIM,NAME,NSIZE,NSIZE,C,IFILE,IMAT,JTAPE,IRR)
      CALL WRTETP(QF,NDIM,NAME,NSIZE,NSIZE,C,IFILE,IMAT,JTAPE,IRR)
      GO TO 500
C
C***** OPTION 3
C
  350 END FILE ITAPE
      CALL WRTETP(CF,NDIM,NAME,NSIZE,NSIZE,C,IFILE,IMAT,ITAPE,IRR)
C
C     TAPE WRITING COMPLETE - TAPE CLOSEOFF DONE IN MAIN PROGRAM
C
C     TEST IF ERROR FLAG IRR HAS BEEN SET
C
  500 IF (IRR)  510,520,510
  510 WRITE(IT6,2003) IRR, FLG1,FLG2,NPHI
      CALL EXIT
  520 RETURN
C
C******************************F O R M A T S ****************************
C
 2000 FORMAT(1H1,2X,14HFREQUENCY NO. ,I3,3X,14HCF(I,J) MATRIX,3X,
     1 8HOMEGA = ,E15.8//)
 2001 FORMAT(1H0,I5,1P6E16.7/(E22.7,5E16.7))
 2002 FORMAT(1H1,2X,14HFREQUENCY NO. ,I3,3X,14HQF(I,J) MATRIX,3X,
     1 8HOMEGA = ,E15.8//)
 2003 FORMAT(1H0,2X,33HERROR RETURN FROM WRTETP , IRR = ,I3,2X,
     1 7HFLG1 = ,I3,2X, 7HFLG2 = ,I3,2X, 7HNPHI = ,I3)
      END
```

SUBROUTINE PEDAN

```
$IBFTC PEDAN*  DECK
      SUBROUTINE PEDAN
C
C
C
C***PEDAN***   IMPEDANCE MATRIX(PEDAN)
C                       SUBROUTINE TO FORM THE REAL AND IMAGINARY PART
C                                  OF THE ADMITTANCE MATRIX BEFORE INVERTING
C
C
C
      COMMON /BLK1/ FREQ,AMASS,OMEGA
      COMMON /BLK2/ M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
         DIMENSION AMASS(25),C(90,90),STIFF(90,90),OMEGA(100),B(16),
     1   AMAT(90,90),FREQ(25),IPARAM(5)
      DIMENSION BMASS(25)
      EQUIVALENCE ( C,STIFF )
      NTAP1 = 10
      NTAP14 = 14
      NTAP15 = 15
      NTAP16 = 16
      REWIND NTAP1
      REWIND NTAP14
      REWIND NTAP15
      REWIND NTAP16
C***                    FORM THE REAL PART OF THE IMPEDANCE MATRIX
C                            *OMEGA**2AMASS(I) + STIFF(I,J)
C
      NAME = 0
      NMAT = 0
      NFILE = 0
C***                    READ IN THE STIFFNESS MATRIX( STIFF )
C
      CALL READTP(STIFF,90,NAME,N,N,B,NFILE,NMAT,NTAP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      NAME = 0
      NMAT = 0
      NFILE = 3
      CALL READTP(BMASS,1,NAME,1,N,B,NFILE,NMAT,NTAP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      NAME = 0
      NMAT = 0
      NFILE = 0
C***
C   START LOOP ( NF TIMES )
C
      DO 200 II = 1,NF
C
C
      DO 150 I = 1,N
      DO 150 J = 1,N
      IF ( I .EQ. J ) GO TO 100
      AMAT(I,J) = STIFF(I,J)
      GO TO 150
 100  AMAT(I,J) = -OMEGA(II)**2*BMASS(I) + STIFF(I,J)
```

```
  150 CONTINUE
C
      CALL WRTETP( AMAT,90,NAME,N,N,B,NFILE,NMAT,NTAP16,IRR )
      IF ( IRR .NE. 0 ) GO TO 9986
C
  200 CONTINUE
C
C
C***READ IN THE DAMPING MATRIX C(NXN)
      READ(5,9002) ((C(I,J),J=1,N),I=1,N)
      WRITE(6,9003)
      DO 250 I = 1,N
      WRITE(6,9004)I,( C(I,J),J=1,N )
  250 CONTINUE
C
C***FORM THE IMAGINARY PART OF THE IMPEDANCE MATRIX
C                   OMEGA*C(I,J)
C
      NAME = 0
      NMAT = 0
      NFILE = 0
C***
C    START LOOP
C
      DO 400 II = 1,NF
C
C
      DO 300 I = 1,N
      DO 300 J = 1,N
  300 AMAT(I,J) = OMEGA(II)*C(I,J)
C
      CALL WRTETP( AMAT,90,NAME,N,N,B,NFILE,NMAT,NTAP15,IRR)
      CALL WRTETP( AMAT,90,NAME,N,N,B,NFILE,NMAT,NTAP15,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
C
  400 CONTINUE
C
C
      END FILE NTAP15
      END FILE NTAP16
      REWIND NTAP15
      REWIND NTAP16
      IF ( N .LE. 50 ) GO TO 500
      IPARAM(1) = 4
      GO TO 510
  500 IPARAM(1) = N
  510 IPARAM(2) = N*N + 3
      IPARAM(3) = NF
      IPARAM(4) = M
      IPARAM(5) = NPLATE + 2*NBEAMS
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP( IPARAM,1,NAME,1,5,B,NFILE,NMAT,NTAP14,IRR )
      IF ( IRR .NE. 0 ) GO TO 9986
      END FILE NTAP14
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
```

```
      CALL EXIT
      RETURN
 9002 FORMAT(7F10.0)
 9003 FORMAT(1H1,40X,14HDAMPING MATRIX //// )
 9004 FORMAT(1H0,I5,1P7E16.6/(E22.6,6E16.6) )
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE PRINTA

```
$IBFTC PRNTA*  DECK
      SUBROUTINE PRINTA
C
C
C***               THE DEFLECTION CROSS-PSD MATRICES FOR OPTION 1
C                    ARE PRINTED.
C
C
C
C
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      DIMENSION A(90,90),FREQ(25),AMASS(25),OMEGA(100),B(16)
      NTAPE = 15
      ITAPE = 16
      REWIND NTAPE
      REWIND ITAPE
      NAME = 0
      NMAT = 0
      NFILE = 0
      WRITE(6,9000)
C
C
C
C***CYCLE ON NUMBER OF FREQUENCIES
      DO 1000 II = 1,NF
      WRITE(6,9005)
      WRITE(6,9001) OMEGA(II)
      CALL READTP(A,90,NAME,N,N,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      DO 100 I = 1,N
      WRITE(6,9002)I,(A(I,J),J=1,N)
 100  CONTINUE
      WRITE(6,9005)
      WRITE(6,9003) OMEGA(II)
      CALL READTP(A,90,NAME,N,N,B,NFILE,NMAT,ITAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      DO 200 I = 1,N
      WRITE(6,9002)I,(A(I,J),J=1,N)
 200  CONTINUE
 1000 CONTINUE
C
C
      REWIND NTAPE
      REWIND ITAPE
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H1,50X,29HDEFLECTION CROSS PSD MATRICES ////)
 9001 FORMAT(1H0,10X,26HDEFLECTION CO-POWER, FREQ=E14.7,12H  (RAD/SEC) /
     1// )
 9002 FORMAT(1H0,I5,1P7E16.6/(E22.6,6E16.6) )
 9003 FORMAT(1H0,10X,28HDEFLECTION QUAD-POWER, FREQ=E14.7,12H  (RAD/SEC)
     1 /// )
 9005 FORMAT(1H0)
```

```
9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
     END
```

SUBROUTINE PRINTB

```
$IBFTC PRNTB*  DECK
      SUBROUTINE PRINTB
C
C
C***                   THE STRESS CROSS-PSD MATRICES ARE PRINTED FOR
C                        PLATES AND BEAMS FOR OPTION 1.
C
C
C
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4
      INTEGER FLG1,FLG2,FLG3,FLG4
      DIMENSION FREQ(25),AMASS(25),OMEGA(100),S(8,8),B(16),SB(6,6)
      NTAPE = 3
      REWIND NTAPE
      NAME = 0
      NMAT = 0
      NFILE = 0
C
C***IF NPLATE EQUALS 0 - SKIP PLATE PRINTOUT
      IF( NPLATE .EQ. 0 ) GO TO 200
C
C
C
      DO 100 II = 1,NPLATE
      WRITE(6,9000) II
C
      DO 50 IJ = 1,NF
      WRITE(6,9001) OMEGA(IJ)
      WRITE(6,9002)
      CALL READTP(S,8,NAME,NR,NC,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      DO 10 I = 1,8
      WRITE(6,9003)I,(S(I,J),J=1,8)
 10   CONTINUE
C
      WRITE(6,9004)
      CALL READTP(S,8,NAME,NR,NC,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      DO 20 I = 1,8
      WRITE(6,9003)I,(S(I,J),J=1,8)
 20   CONTINUE
C
 50   CONTINUE
C
C
 100  CONTINUE
C
C
C
C***IF NBEAMS EQUALS 0 - SKIP BEAM PRINTOUT
 200  IF(NBEAMS .EQ. 0 ) RETURN
C
C
C
```

```
      DO 1000 II = 1,NBEAMS
      WRITE(6,9005) II
C
      DO 150 IJ = 1,NF
      WRITE(6,9001) OMEGA(IJ)
      DO 140 I1 = 1,2
      CALL READTP(SB,6,NAME,NR,NC,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      WRITE(6,9010) I1
      WRITE(6,9002)
C
      DO 80 I = 1,6
      WRITE(6,9011)I,(SB(I,J),J=1,6)
 80   CONTINUE
C
      CALL READTP(SB,6,NAME,NR,NC,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      WRITE(6,9004)
C
      DO 90 I=1,6
      WRITE(6,9012)I,(SB(I,J),J=1,6)
 90   CONTINUE
C
 140  CONTINUE
C
 150  CONTINUE
C
C
C
 1000 CONTINUE
C
C
C
      REWIND NTAPE
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H0,6HPLATE I3 )
 9001 FORMAT(5X,10HFREQUENCY=E14.7)
 9002 FORMAT(1H0,15X,9HREAL PART///)
 9003 FORMAT(1H0,14X,I5,8E14.5/(20X,8E14.5) )
 9004 FORMAT(1H0,15X,9HIMAG PART///)
 9005 FORMAT(1H0,6H BEAM I3//)
 9010 FORMAT(10X,4HEND I3///)
 9011 FORMAT(1H0,20X,I5,6E14.5/(26X,6E14.5) )
 9012 FORMAT(1H0,20X,I5,6E14.5/(26X,6E14.5) )
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
      END
```

SUBROUTINE CONS

```
$IBFTC CONS*   DECK
      SUBROUTINE CONS
C
C
C***                ROUTINE TO CALCULATE THE CONSTANTS USED IN THE
C                     TRAPEZOIDAL INTEGRATION FORMULA.
C
C
C
      COMMON /BLK1/ FREQ,AMASS,OMEGA
      COMMON /BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      DIMENSION FREQ(25),AMASS(25),OMEGA(100),X(100),H(100),C(100)
     1     ,B(16)
      EQUIVALENCE ( OMEGA,X )
C     THE CONSTANTS ARE C0, C1.AND C2 CALCULATED OVER THE TOTAL INTERVAL.
      NTAPE = 4
      REWIND NTAPE
      N2 = NF - 2
      NN = NF - 1
C
      DO 10 I=1,NN
 10   H(I) = X(I+1)-X(I)
C
      C(1) = H(1)/2.0
      C(NF) = H(NN)/2.
C
      DO 150 I = 2,NN
      C(I)=(H(I-1)+H(I))/2.
 150  CONTINUE
C
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(C,1,NAME,NF,1,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      END FILE NTAPE
      RETURN
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE PRINTC

```
$IBFTC PRNTC*  DECK
      SUBROUTINE PRINTC
C
C
C***                 THE DEFLECTION CO-VARIANCE MATRICES ARE PRINTED FOR
C                      OPTION 1.
C
C
C
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      DIMENSION A(90,90),B(16)
      NTAPE = 12
      REWIND NTAPE
      NAME = 0
      NMAT = 0
      NFILE = 0
      WRITE(6,9000)
      WRITE(6,9001)
      CALL READTP(A,90,NAME,N,N,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      DO 100 I = 1,N
      WRITE(6,9002) I,(A(I,J),J=1,N )
 100  CONTINUE
C
      WRITE(6,9005)
      WRITE(6,9003)
      CALL READTP(A,90,NAME,N,N,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      DO 200 I = 1,N
      WRITE(6,9002)9,(A(I,J),J=1,N)
 200  CONTINUE
C
      REWIND NTAPE
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H1,30X,30HDEFLECTION CO-VARIANCE MATRIX  ///)
 9001 FORMAT(1H0,10X,9HREAL PART ///)
 9002 FORMAT(1H0,I5,1P7E16.6/(E22.6,6E16.6) )
 9003 FORMAT(1H0,10X,14HIMAGINARY PART  ///)
 9005 FORMAT(1H0)
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
      END
```

SUBROUTINE PRINTD

```
$IBFTC PRNTD*  DECK
      SUBROUTINE PRINTD(IR,NTAPE,NFF)
C
C
C***                  THE STRESS MATRICES ARE PRINTED FOR
C                       OPTIONS  1, 2 AND 3
C
C
C
      COMMON /BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4
      DIMENSION S(8,8),B(16),SB(6,6)
      DIMENSION FREQ(25),AMASS(25),OMEGA(100)
      INTEGER FLG1,FLG2,FLG3,FLG4
      REWIND NTAPE
      NAME = 0
      NMAT = 0
      NFILE = 0
C
C
C
      DO 800 III = 1,IR
      IF ( III .EQ. 2 ) GO TO 80
      WRITE(6,9001)
      GO TO 90
 80   WRITE(6,9010)
 90   IF ( NPLATE .EQ. 0 ) GO TO 200
C
      DO 500 INF = 1,NFF
      IF ( NFF .EQ. 1 ) GO TO 99
      WRITE(6,9020) OMEGA(INF)
 99   CONTINUE
C
C
      DO 100 II = 1,NPLATE
      CALL READTP(S,8,NAME,NR,NC,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      WRITE(6,9002)II
      DO 110 I = 1,8
      WRITE(6,9003)I,(S(I,J),J=1,8)
 110  CONTINUE
 100  CONTINUE
 200  IF ( NBEAMS .EQ. 0 ) GO TO 500
C
      DO 400 II = 1,NBEAMS
      WRITE(6,9004) II
      DO 380 IJ = 1,2
      WRITE(6,9005)IJ
      CALL READTP(SB,6,NAME,NR,NC,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      DO 360 I = 1,6
      WRITE(6,9006)I,(SB(I,J),J=1,6 )
C
 360  CONTINUE
C
 380  CONTINUE
```

```
C
 400  CONTINUE
C
 500  CONTINUE
C
C
C
 800  CONTINUE
C
C
C
      REWIND NTAPE
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
      RETURN
 9001 FORMAT(1H0,10X,9HREAL PART ///)
 9002 FORMAT(1H0,6HPLATE I3)
 9003 FORMAT(1H0,5X,I5,8E14.5/(11X,8E14.5) )
 9004 FORMAT(1H0,6H BEAM I3 )
 9005 FORMAT(11X,4HEND I3 )
 9006 FORMAT(20X,I5,6E14.5/(25X,6E14.5) )
 9010 FORMAT(1H0,10X,14HIMAGINARY PART ///)
 9020 FORMAT(1H0,27HSTRESS CO-POWER, FREQUENCY=E14.7,9H(RAD/SEC) )
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
      END
```

SUBROUTINE DSECM1

```
$IBFTC DSEC1*  DECK
      SUBROUTINE DSECM1
C
C
C***                  THE DEFLECTION SECOND SPECTRAL MOMENTS ARE
C                       CALCULATED FOR OPTION 1.
C                     THE JOINT DEFLECTION MATRICES FORMED IN SUBROUTINE
C                       DJNT1 ARE MULTIPLIED BY ITS APPROPRIATE FREQ**2
C                       AND CONSTANTS AND SUMMED TOGETHER TO FORM THE
C                       DEFLECTION SECOND SPECTRAL MOMENTS MAYRIES
C                       DEFLECTION SECOND SPECTRAL MOMENT MATRICES
C                       ( REAL PART AND IMAGINARY PART ).
C
C
C
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      DIMENSION FREQ(25),AMASS(25),OMEGA(100),AMAT(90,90),SMAT(90,90)
     1    ,B(16)
      DIMENSION C(100)
      NTAP12 = 12
      NTAP4 = 4
      NTAP15 = 15
      NTAP16 = 16
      REWIND NTAP12
      REWIND NTAP4
      REWIND NTAP15
      REWIND NTAP16
C
C***PRINT TITLE HEADINGS
      WRITE(6,9000)
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL READTP(C,1,NAME,NF,1,B,NFILE,NMAT,NTAP4 ,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      DO 5 I = 1,N
      DO 5 J = 1,N
 5    SMAT(I,J) = 0.
C
      NTAPE = NTAP15
C
C***LOOP ON REAL AND IMAGINARY
      DO 50 III = 1,2
      IF ( III .EQ. 2 ) NTAPE = NTAP16
      DO 40 II = 1,NF
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL READTP(AMAT,90,NAME,N,N,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      DO 20 I = 1,N
      DO 20 J = 1,N
 20   SMAT(I,J) = SMAT(I,J) + AMAT(I,J)*OMEGA(II)**2*C(II)
 40   CONTINUE
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(SMAT,90,NAME,N,N,B,NFILE,NMAT,NTAP12,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      IF ( III .EQ. 1 ) GO TO 45
      WRITE(6,9005)
      WRITE(6,9001)
      DO 42 I = 1,N
      WRITE(6,9002)I,(SMAT(I,J),J=1,N)
 42   CONTINUE
      GO TO 50
 45   WRITE(6,9003)
      DO 48 I = 1,N
      WRITE(6,9002)I,(SMAT(I,J),J=1,N)
 48   CONTINUE
 50   CONTINUE
C
C
      END FILE NTAP12
      REWIND NTAP12
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H1,30X,41HDEFLECTION SECOND SPECTRAL MOMENT MATRIX   ////)
 9001 FORMAT(1H0,10X,14HIMAGINARY PART  ///)
 9002 FORMAT(1H0,I5,1P7E16.6/(E22.6,6E16.6) )
 9003 FORMAT(1H0,10X,9HREAL PART  ///)
 9005 FORMAT(1H0)
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE ADMIN3

```
$IBFTC ADMN3*  DECK
      SUBROUTINE ADMIN3
C
C
C
C
C              *                                         *
C             * A D M I T T A N C E   I N T E G R A L S *
C            *                                             *
C             * U S E D   I N   F O R M I N G   T H E *
C              *                                         *
C               * J O I N T   D E F L E C T I O N S   *
C                *                                   *
C                         ( OPTION 3 )
C
C
C  OPTION 3      BROAD BAND EXCITATIONS, DAMPING COEFFICIENTS PROPORTIONAL
C                TO A LINEAR COMBINATION OF THE MASS INERTIA AND STIFFNESS
C                COEFFICIENTS. ( NO CROSS MODAL COUPLING IS INCLUDED )
C
C  M             NUMBER OF FREQUENCIES, MASS AND MODE SHAPES
C  N             NUMBER OF RETAINED DEGREES OF FREEDOM
C  G             STRUCTURAL DAMPING
C  ALAM          A DAMPING PROPORTIONALITY FACTOR PROP. TO STIFFNESS
C  CMU           A DAMPING PROPORTIONALITY FACTOR FOR DAMPING PROPORTIONAL
C                  TO MASS.
      DIMENSION FREQ(25), AMASS(25), AMU(25), DIAG(25), PHIM(25),
     1          PHI(100,25), B(16),NSTO(1)
      COMMON /BLK1/ FREQ, AMASS
      COMMON /BLK2/ M,N,G,ALAM,CMU
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4
      INTEGER FLG1,FLG2,FLG3,FLG4
      NTAP1 = 10
      NTAP11 = 11
      REWIND NTAP1
      REWIND NTAP11
C
C***FORM THE PARAMETER MATRIX AND STORE ON TAPE
      NSTO(1) = M
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(NSTO,1,NAME,1,1,B,NFILE,NMAT,NTAP11,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
C***                                    DAMPING FACTOR
C
      DO 10 I = 1,M
 10   AMU(I) = CMU + ALAM*FREQ(I)**2 + G*FREQ(I)
C
C
C***                                    DIAGONAL SCALARS ARE COMPUTED
      IF ( FLG1 .EQ. 2 ) GO TO 15
      WRITE(6,9000)
      GO TO 18
 15   WRITE(6,9002)
 18   DO 20 I = 1,M
 20   DIAG(I) = 3.14159265/(2.0*AMU(I)*FREQ(I)**2*AMASS(I)**2)
```

```
      WRITE(6,9001) ( I,DIAG(I),I=1,M )
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(DIAG,1,NAME,1,M,B,NFILE,NMAT,NTAP11,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      NAME = 0
      NMAT = 1
      NFILE = 2
C
C***                                      THE MODE SHAPES ARE READ IN.
C
      CALL READTP(PHI,100,NAME,N,M,B,NFILE,NMAT,NTAP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      NAME = 0
      NFILE =0
      NMAT = 0
C
      DO 50 J=1,M
      DO 40 I=1,N
 40   PHIM(I) = PHI(I,J)
      CALL WRTETP(PHIM,1,NAME,N,1,B,NFILE,NMAT,NTAP11,IRR)
 50   CONTINUE
C
      END FILE NTAP11
      REWIND NTAP1
      REWIND NTAP11
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H1,40X,20HADMITTANCE INTEGRALS //// )
 9001 FORMAT(10X,I5,5X,E14.7 )
 9002 FORMAT(1H1,40X,38HADMITTANCE INTEGRALS (NO CROSS TERMS) /// )
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE ADDMAT

```
$IBFTC ADDMA*  DECK
      SUBROUTINE ADDMAT( INTAPE, OUTAPE, NO )
C
C                   * *                               * *
C                  *          M   A   T   R   I   X      *
C                 *                                        *
C                 * A D D I T I O N   R O U T I N E        *
C                 *                                        *
C                  * * *                               * * *
C
C                           (MATRIX SIZE IS NXN)
C
C***  INTAPE -           THERE ARE M NO. OF MATRICES STORED ON THIS TAPE.
C***  OUTAPE -           THE SUM OF M MATRICES ARE STORED ON THIS TAPE.
C
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4,MF,NRI
      DIMENSION SUM(90,90),AMAT(90,90),B(16),IPARAM(2)
      DIMENSION FREQ(25),AMASS(25),OMEGA(100)
      INTEGER OUTAPE
      INTEGER FLG1,FLG2,FLG3,FLG4
      REWIND INTAPE
      REWIND OUTAPE
      NAME = 0
      NMAT = 0
      NFILE = 0
C
C***FORM PARAMETER  MATRIX IPARAM
      IPARAM(1) = NPLATE + 2*NBEAMS
      IPARAM(2) = NO
      CALL WRTETP(IPARAM,1,NAME,1,2,B,NFILE,NMAT,OUTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      IF ( FLG1 .EQ. 3 ) GO TO 5
      GO TO 8
 5    IF ( FLG2 .EQ. 1 ) GO TO 6
      GO TO 7
 6    WRITE(6,9001)
      GO TO 8
 7    WRITE(6,9002)
 8    CONTINUE
C
C
      DO 500 III = 1,NO
      IF ( FLG1 .EQ. 2 ) GO TO 11
      IF ( FLG2 .EQ. 1 ) GO TO 9
      WRITE(6,9003) OMEGA(III)
 9    CONTINUE
C
C***LOOP ON REAL AND IMAGINARY
 11   DO 400 IR = 1,NRI
C
      DO 10 I=1,N
      DO 10 J=1,N
 10   SUM(I,J) = 0.
C
C***BEGINNING OF LOOP TO SUM M MATRICES.
```

```
C
C
C
      DO 300 II = 1,MF
      NAME = 0
      NFILE = 0
      NMAT = 0
      CALL READTP(AMAT,90,NAME,N,N,B,NFILE,NMAT,INTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C***READ IN A MATRIX FROM INTAPE
C
      DO 100 I = 1,N
      DO 100 J = 1,N
 100  SUM(I,J) = SUM(I,J) + AMAT(I,J)
 300  CONTINUE
C
C***END OF LOOP TO SUM M MATRICES.
C
C
      IF ( FLG1 .EQ. 2 ) GO TO 360
      DO 350 I = 1,N
      WRITE(6,9000)I,(SUM(I,J),J=1,N)
 350  CONTINUE
C
 360  NAME = 0
      NFILE = 0
      NMAT = 0
C***WRITE THE SUMMATION MATRIX ON OUTAPE.
      CALL WRTETP(SUM,90,NAME,N,N,B,NFILE ,NMAT,OUTAPE ,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
 400  CONTINUE
 500  CONTINUE
C
C
      END FILE OUTAPE
      REWIND INTAPE
      REWIND OUTAPE
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H0,I5,1P7E16.6/(E22.6,6E16.6) )
 9001 FORMAT(1H1,30X,37HDEFLECTION CO-VARIANCE MATRIX (REAL) ///)
 9002 FORMAT(1H1,30X,39HBELOW ARE DEFLECTION CROSS-PSD MATRICES /// )
 9003 FORMAT(1H0,31HDEFLECTION CO-POWER, FREQUENCY=F12.6,11H (RAD/SEC) ,
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE ADMIN2

```
$IBFTC ADMN2*  DECK
      SUBROUTINE ADMIN2
C                      *                                       *
C                     * A D M I T T A N C E   I N T E G R A L S *
C                    *                                           *
C                    *  U S E D   I N   F O R M I N G   T H E    *
C                     *                                         *
C                      *  J O I N T   D E F L E C T I O N S    *
C
C                       *                                     *
C   OPTION 2      BROAD BAND EXCITATION, DAMPING COEFFICIENTS PROPORTIONAL
C                 TO A LINEAR COMBINATION OF THE MASS INERTIA AND STIFFNESS
C                 COEFFICIENTS. ( CROSS MODAL COUPLING IS INCLUDED )
C
C
C   M             NUMBER OF FREQUENCIES, MASS AND MODE SHAPES
C
C
C                 THE FREQUENCIES(FREQ), GENERALIZED MASS(AMASS) AND
C                 MODE SHAPES(PHI) COME FROM THE EIGENVECTOR-EIGENVALUE
C                 ROUTINE TV-105W.
C
C   N             NUMBER OF RETAINED DEGREES OF FREEDOM
C   NF            NUMBER OF FREQUEUNCIES TO CALCULATE THE CPSD
C   G             STRUCTURAL DAMPING
C   ALAM          A DAMPING PROPORTIONALITY FACTOR PROP. TO STIFFNESS
C   CMU           A DAMPING PROPORTIONALITY FACTOR FOR DAMPING PROPORTIONAL
C                   TO MASS.
C
C***TAPE OUTPUT STORAGE - TAPE 16
C                    *****
C      MATRIX 1      *M-1* PARAMETER MATRIX(3X1)
C                    *K  *
C                    *N  *
C                    *****
C
C      MATRIX 2        0     PARAMETER K MATRIX USED FOR OFF-DIAG TEST
C                   OR -1       ( M-1 BY 1 )
C
C
C      MATRIX 3        PHI(I,J)     I=1,M-1
C                                   J=I,I+K
C
      DIMENSION DE(25,25), ED(25,25), DDEE(25,25), AMU(25), AMASS(25),
     1FREQ(25),OM4(25),X7(25),FREQ4(25),X8(25),SC1(25,25),
     2SC2(25,25),SMAT(3),B(16),PHI(100,25),PHIM(100),NSTO(3),KPARAM(24)
      COMMON /BLK1/ FREQ,AMASS
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS,NLOOP
      PI = 3.14159265
      NTAP1 = 10
      NTAP12 = 12
      NTAP16=16
      REWIND NTAP1
      REWIND NTAP12
      REWIND NTAP16
C
      DO 20 I=1,M
```

```
   20 AMU(I)=CMU+ALAM*FREQ(I)**2+G*FREQ(I)
C
C     THE FREQUENCIES AND MU ARE SCALED
      CALL SCALE( FREQ, M, SCAL )
C
      DO 25 I = 1,M
   25 AMU(I) = AMU(I)/SCAL
C
      MM=M-1
C
C***FORM PARAMETER MATRIX NSTO
      NSTO(1) = MM
      NSTO(2) = K
      NSTO(3) = N
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(NSTO,1,NAME,3,1,B,NFILE,NMAT,NTAP16,IRR)
      IF ( IRR .NE. 0 ) GO TO 9999
C***FORM PARAMETER K MATRIX TO TEST FOR NUMBER OF OFF-DIAGONAL TERMS
C          ARE DESIRED
C
      MK = M-K
      DO 30 I=1,MK
   30 KPARAM(I) = 0
      MK = MK+1
      IF ( MK .GT. MM ) GO TO 50
      DO 40 I = MK,MM
   40 KPARAM(I) = -1
   50 NAME = 0
      NMAT = 0
      NFILE = 0
      IF ( K .EQ. 1 ) GO TO 55
      GO TO 58
   55 KPARAM(M) = -1
      MM = M
   58 CONTINUE
      CALL WRTETP(KPARAM,1,NAME,MM,1,B,NFILE,NMAT,NTAP16,IRR)
      IF ( IRR .NE. 0 ) GO TO 9999
      IF ( K .EQ. 1 ) MM = M-1
      NAME = 0
      NMAT=1
      NFILE = 2
      CALL READTP(PHI,100,NAME,N,M,B,NFILE,NMAT,NTAP1,IRR)
      IF(IRR .NE. 0)GO TO 9998
      NAME = 0
      NMAT=0
      NFILE = 0
C     THE MODE SHAPES PHI ARE STORED ON TAPE
C****
      DO 90 II=1,MM
      J1 = II
      ML = II+K
      IF( ML .GT. M ) ML = M
      DO 90 J = J1,ML
      DO 80 I=1,N
   80 PHIM(I)=PHI(I,J)
      CALL WRTETP(PHIM,1,NAME,N,1,B,NFILE,NMAT,NTAP16,IRR)
      IF ( IRR .NE. 0 ) GO TO 9999
   90 CONTINUE
```

```
C****
C****
C           THE ADMITTANCE INTEGRALS FOR OPTION 2 ARE FORMED AT M
C            NUMBER OF FREQUENCIES.
C****
      DO 100 I=1,M
      FREQ4(I)=FREQ(I)**4
      X7(I)=AMU(I)**2-2.*FREQ(I)**2
  100 X8(I)=SQRT(4.*FREQ(I)**2-AMU(I)**2)*AMU(I)
C
C
      DO 130 I=1,M
      DO 120 J=1,M
      IF(I .NE. J)GO TO 110
      DE(I,J) = 0.
      ED(J,I) = 0.
      GO TO 120
  110 X2=FREQ(I)**2-FREQ(J)**2
      X3 = FREQ4(I) - FREQ4(J)
      X4 = AMU(J)*FREQ(I)**2
      X5 = AMU(I)**2 - AMU(J)**2
      X6 = FREQ(J)**4/FREQ(I)**4
      BMAT = ( X3*(-X4*X7(I)-AMU(J)*FREQ4(I) )+X4*(FREQ4(I)*X7(J)-FREQ4
     1(J)*X7(I)) )/( FREQ4(I)*(X5-2.*X2)*(FREQ4(I)*X7(J)-FREQ4(J)*X7(I))
     2-FREQ4(I)*X3**2 )
      AMAT = ( BMAT*FREQ4(I)*( X5-2.*X2 )-X4 )/X3
      CMAT = X4/FREQ4(I) - X6*AMAT
      X=BMAT*ALOG(X6)/2.+(AMAT-BMAT*X7(I)/2.)*PI/X8(I)
      X = X + ( CMAT + BMAT*X7(J)/2. )*PI/X8(J)
      DE(I,J) = X/( 2.*AMASS(I)*AMASS(J)   )
      ED(J,I) = DE(I,J)
  120 CONTINUE
  130 CONTINUE
C
C
      DO 3000 I =1,M
      DO 3000 J = 1,M
      DDEE(I,J) = ( PI*( AMU(I)+AMU(J)) )/( AMASS(I)*AMASS(J)*( FREQ4(J)
     1 + AMU(I)**2 *FREQ(J)**2 + AMU(I)*AMU(J)*FREQ(J)**2 + FREQ4(I) +
     2 AMU(I)*AMU(J)*FREQ(I)**2 + AMU(J)**2*FREQ(I)**2 - 2.*FREQ(I)**2*
     3 FREQ(J)**2 ) )
 3000 CONTINUE
      DO 4000 I=1,M
      DO 4000 J=1,M
      DE(I,J) = DE(I,J)/SCAL**3
      ED(J,I)=DE(I,J)
C     THE SCALARS ARE RESCALED BY DIVIDING BY SCALE FACTOR CUBED.
      DDEE(I,J) = DDEE(I,J)/SCAL**3
 4000 CONTINUE
      WRITE(6,9000)
      WRITE(6,9001)
      DO 4100 I = 1,M
      WRITE(6,9002)I
      WRITE(6,9003) ( J,DE(I,J),DDEE(I,J),J=1,M)
      WRITE(6,9004)
 4100 CONTINUE
C
      MM=M-1
C
      DO 5000 I=1,MM
      M1=I+1
      DO 5000 J=M1,M
      SC1(I,J)=DE(I,J)-DE(J,I)
      SC2(I,J)=-SC1(I,J)
 5000 CONTINUE
C
      NAME = 0
      NMAT=0
      NFILE=0
      MM=M-1
C
C****
C   SMAT(1)   =   D(I)*D(J) + E(I)*E(J)     (INTEGRATE)
C   SMAT(2)   =   D(I)*E(J) - D(J)*E(I)     (INTEGRATE)
C   SMAT(3)   =   D(J)*E(I) - D(I)*E(J)     (INTEGRATE)
C
C
      NAME = 0
      NMAT = 0
      NFILE = 0
C
      DO 6000 I=1,MM
      M1=I+1
      ML = I + K
      IF( ML .GT. M ) ML = M
      DO 6000 J = M1,ML
      SMAT(1)=DDEE(I,J)
      SMAT(2)=SC1(I,J)
      SMAT(3)=SC2(I,J)
      CALL WRTETP(SMAT,1,NAME,3,1,B,NFILE,NMAT,NTAP12,IRR)
      IF ( IRR .NE. 0 ) GO TO 9999
 6000 CONTINUE
C
      DO 6050 I = 1,M
 6050 FREQ(I) = FREQ(I)*SCAL
C
      END FILE NTAP12
      END FILE NTAP16
      RETURN
 9998 WRITE(6,9010)IRR
      CALL EXIT
 9999 WRITE(6,9020)IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H1,50X,21HADMITTANCE INTEGRALS ////)
 9001 FORMAT(1H0,10X,9HD(I)*E(J),20X,22HD(I)*D(J) + E(I)*E(J)   ///)
 9002 FORMAT(1H0,3H I=I3)
 9003 FORMAT(7X,I3,1X,E14.7,10X,E14.7)
 9004 FORMAT(1H0)
 9010 FORMAT(28H ERROR IN READTP ERROR CODE=I5)
 9020 FORMAT(28H ERROR IN WRTETP ERROR CODE=I5)
      END
```

SUBROUTINE CQJD

```
$IBFTC CQJD*   DECK
      SUBROUTINE CQJD
      COMMON/BLK2/M,N,G,ALAM,CMU,K
         DIMENSION SMAT(3),B(16),CFW(90,90),QFW(90,90)
      NTAP12 = 12
      NTAP15 = 15
      NTAP17 = 2
      NTAP18 = 14
      REWIND NTAP12
      REWIND NTAP15
      REWIND NTAP17
      REWIND NTAP18
      IQ = 0
      MM = M-1
C
C
C***CALCULATE THE EXCITATIONS
C           LOOP II=1,2         WHEN II=1 THE EXCITATIONS FOR REAL PART
C                                         ARE STORED ON TAPE 15
C                               WHEN II=2 THE EXCITATIONS FOR IMAGINARY
C                                         PART ARE STORED ON TAPE 15
      DO 500 II = 1,2
C
      DO 200 I = 1,MM
      M1 = I + 1
      ML = I+K
      IF( ML .GT. M ) ML=M
      DO 200 J = M1,ML
      NAME = 0
      NMAT = 0
      NFILE = 0
C***READ IN THE ADMITTANCE INTEGRAL SCALARS
      CALL READTP(SMAT,1,NAME,NR,NC,B,NFILE,NMAT,NTAP12,IRR)
      IF( IRR .NE. 0 ) GO TO 9998
      NAME = 0
      NMAT = 0
      NFILE = 0
C***READ IN THE CO-POWER SPECTRAL DENSITY(CFW)
      CALL READTP(CFW,90,NAME,N,N,B,NFILE,NMAT,NTAP17,IRR)
      IF( IRR .NE. 0 ) GO TO 9998
C***READ IN THE QUAD-POWER SPECTRAL DENSITY(QFW)
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL READTP(QFW,90,NAME,N,N,B,NFILE,NMAT,NTAP18,IRR)
      IF( IRR .NE. 0 ) GO TO 9998
C***FORM THE EXCITATION MATRIX TO BE STORED ON TAPE 15
      IF( IQ  .NE. 0 ) GO TO 54
      DO 50 K1=1,N
      DO 50 L1 = 1,N
 50   CFW(K1,L1) = CFW(K1,L1)*SMAT(1) + QFW(K1,L1)*SMAT(2)
      GO TO 80
 54   DO 55 K1 = 1,N
      DO 55 L1 = 1,N
 55   CFW(K1,L1) = CFW(K1,L1)*SMAT(3)  + QFW(K1,L1)*SMAT(1)
 80   NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(CFW,90,NAME,N,N,B,NFILE,NMAT,NTAP15,IRR)
      IF( IRR .NE. 0 ) GO TO 9999
  200 CONTINUE
C***REWIND THE TAPES USED IN CALCULATING THE IMAGINARY PART
      REWIND NTAP12
      REWIND NTAP17
      REWIND NTAP18
      IQ = 1
  500 CONTINUE
C
C
      END FILE NTAP15
      RETURN
 9998 WRITE(6,9010) IRR
      CALL EXIT
 9999 WRITE(6,9020) IRR
      CALL EXIT
      RETURN
 9010 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9020 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE SUMT

```
$IBFTC SUMT*   DECK
      SUBROUTINE SUMT ( NO, INTAPE)
C
C
C                     SUBROUTINE SUMT - A MATRIX WILL BE ADDED TO ITS
C                       TRANSPOSE .
C
C
C
      COMMON /BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      DIMENSION SUM(90,90),AMAT(90,90),B(16),IPARAM(2)
      NTAP8 = 8
      REWIND NTAP8
      REWIND INTAPE
C
C
C
C***CYCLE ON REAL AND IMAGINARY
      DO 600 III = 1,2
      IF ( III .EQ. 1 ) GO TO 50
      NMAT = 0
C
C***SET SIGN = -1  FOR THE IMAGINARY PART
      SIGN = -1.0
      GO TO 60
 50   NMAT = 1
C
C***SET SIGN = 1  FOR THE REAL PART
      SIGN = 1.0
 60   CONTINUE
C
      DO 500 II = 1,NO
      NAME = 0
      NFILE = 0
      CALL READTP(AMAT,90,NAME,N,N,B,NFILE,NMAT,INTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      DO 100 I = 1,N
      DO 100 J = 1,N
 100  SUM(I,J) = AMAT(I,J) + AMAT(J,I)*SIGN
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(SUM,90,NAME,N,N,B,NFILE,NMAT,NTAP8,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
 500  CONTINUE
 600  CONTINUE
C
C
C
      END FILE NTAP8
      REWIND NTAP8
      REWIND INTAPE
      NAME = 0
      NMAT = 0
      NFILE = 0
C
C***A PARAMETER MATRIX IPARAM IS FORMED
```

```
      IPARAM(1) = NPLATE + 2*NBEAMS
      IPARAM(2) = NO
      CALL WRTETP(IPARAM,1,NAME,1,2,B,NFILE,NMAT,INTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
C
C
C
C***CYCLE ON REAL AND IMAGINARY
      DO 900 III = 1,2
      DO 800 II = 1,NO
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL READTP(AMAT,90,NAME,N,N,B,NFILE,NMAT,NTAP8,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(AMAT,90,NAME,N,N,B,NFILE,NMAT,INTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
 800  CONTINUE
 900  CONTINUE
C
C
C
      END FILE INTAPE
      REWIND INTAPE
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE SUM2

```
$IBFTC SUM2*   DECK
      SUBROUTINE SUM2( ITP1,ITP2,NO,NCN )
C
C
C                         SUBROUTINE SUM2 - SUMS THE OPTION 3 LIKE
C                           MODE EFFECTS TO UNLIKE MODE EFFECTS TO FORM
C                           TOTAL OPTION 2 RESULTS.
C
C
C
      COMMON /BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      DIMENSION AMAT(90,90),BMAT(90,90),B(16),IPARAM(2)
      REWIND ITP1
      REWIND ITP2
      NAME = 0
      NMAT = 1
      NFILE = 0
      CALL READTP(AMAT,90,NAME,N,N,B,NFILE,NMAT,ITP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      REWIND ITP1
      NAME = 0
      NMAT = 1
      NFILE = 0
      CALL READTP(BMAT,90,NAME,N,N,B,NFILE,NMAT,ITP2,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      DO 100 I = 1,N
      DO 100 J = 1,N
  100 AMAT(I,J) = AMAT(I,J) + BMAT(I,J)
C
C*** ADD OPTION 3 LIKE MODES TO OPTION 2 UNLIKE MODE EFFECTS TO
C    GET THE TOTAL JOINT DEFLECTIONS
      IF ( NCN .EQ. 1 ) GO TO 200
      WRITE(6,9000)
      GO TO 250
  200 WRITE(6,9001)
C
  250 DO 500 I = 1,N
      WRITE(6,9002)I,(AMAT(I,J),J=1,N)
  500 CONTINUE
C
C
C***A PARAMETER MATRIX NSTO IS FORMED
      IPARAM(1) = NPLATE + 2*NBEAMS
      IPARAM(2) = NO
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(IPARAM,1,NAME,1,2,B,NFILE,NMAT,ITP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      CALL WRTETP(AMAT,90,NAME,N,N,B,NFILE,NMAT,ITP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      CALL READTP(AMAT,90,NAME,N,N,B,NFILE,NMAT,ITP2,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      CALL WRTETP(AMAT,90,NAME,N,N,B,NFILE,NMAT,ITP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      IF ( NCN .EQ. 1 ) GO TO 800
```

SUBROUTINE SECM3

```
$IBFTC SECM3*  DECK
      SUBROUTINE SECM3
C
C
C
C
C
C              *                                       *
C             * A D M I T T A N C E   I N T E G R A L S *
C            *                                           *
C           *   U S E D   I N    F O R M I N G    T H E   *
C          *                                               *
C           *   D E F L E C T I O N   S E C O N D         *
C            *                                          *
C             * M O M E N T S .                         *
C              *                                       *
C               *                                     *
C
C
C                        ( OPTION 3 )
C
C
C  OPTION 3    BROAD BAND EXCITATIONS, DAMPING COEFFICIENTS PROPORTIONAL
C              TO A LINEAR COMBINATION OF THE MASS INERTIA AND STIFFNESS
C              COEFFICIENTS. ( NO CROSS MODAL COUPLING IS INCLUDED )
C
C  M           NUMBER OF FREQUENCIES, MASS AND MODE SHAPES
C  N           NUMBER OF RETAINED DEGREES OF FREEDOM
C  G           STRUCTURAL 4AMPING
C  ALAM        A DAMPING PROPORTIONALITY FACTOR PROP. TO STIFFNESS
C  CMU         A DAMPING PROPORTIONALITY FACTOR FOR DAMPING PROPORTIONAL
C                TO MASS.
      D+MENSION FREQ(25), AMASS(25), AMU(25), DIAG(25), PHIM(25),
     1          PHI(100,25),B(16),NSTO(1)
      COMMON /BLK1/ FREQ, AMASS
      COMMON /BLK2/ M,N,G,ALAM,CMU
      NTAP1 = 10
      NTAP11 = 11
      REWIND NTAP1
      REWIND NTAP11
      NSTO(1) = M
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(NSTO,1,NAME,1,1,B,NFILE,NMAT,NTAP11,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
C***                                   DAMPING FACTOR
C
      DO 10 I = 1,M
 10   AMU(I) = CMU + ALAM*FREQ(I)**2 + G*FREQ(I)
C
C
C***                                   DIAGONAL SCALARS ARE COMPUTED
      DO 20 I = 1,M
      PI = 3.14159265
 20   DIAG(I) = PI/( 2.0*AMU(I)*AMASS(I)**2 )
      NAME = 0
      WRITE(6,9003)
      GO TO 900
  800 WRITE(6,9004)
C
  900 DO 950 I = 1,N
      WRITE(6,9002)I,(AMAT(I,J),J=1,N)
  950 CONTINUE
C
      END FILE ITP1
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H1,30X,55HDEFLECTION SECOND SPECTRAL MOMENT MATRIX ( REAL
     1PART )   ///)
 9001 FORMAT(1H1,30X,43HDEFLECTION COVARIANCE MATRIX ( REAL PART )  ///)
 9002 FORMAT(1H0,I5,1P7E16.6/(E22.6,6E16.6) )
 9003 FORMAT(1H1,30X,59HDEFLECTION SECOND SPECTRAL MOMENT MATRIX ( IMAGI
     1NARY PART ) //)
 9004 FORMAT(1H1,30X,48HDEFLECTION COVARIANCE MATRIX ( IMAGINARY PART )
     1  //)
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
      NMAT = 0
      NFILE = 0
      CALL WRTETP(DIAG,1,NAME,1,M,B,NFILE,NMAT,NTAP11,IRR)
      NAME = 0
      NMAT = 1
      NFILE = 2
C
C***                                   THE MODE SHAPES ARE READ IN.
C
      CALL READTP(PHI,100,NAME,N,M,B,NFILE,NMAT,NTAP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      NAME = 0
      NMAT = 0
      NFILE =0
C
      DO 50 J=1,M
      DO 40 I=1,N
 40   PHIM(I) = PHI(I,J)
      CALL WRTETP(PHIM,1,NAME,N,1,B,NFILE,NMAT,NTAP11,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
 50   CONTINUE
C
      END FILE NTAP11
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE SECM2

```
$IBFTC SECM2*  DECK
      SUBROUTINE SECM2
C
C              *                                        *
C             * A D M I T T A N C E    I N T E G R A L S *
C            *                                            *
C           *  U S E D    I N    F O R M I N G    T H E    *
C          *                                                *
C           *  D E F L E C T I O N    S E C O N D          *
C            *                                            *
C             * M O M E N T S .                          *
C              *                                        *
C               *                                      *
C
C
C
C
C   OPTION 2      BROAD BAND EXCITATION, DAMPING COEFFICIENTS PROPORTIONAL
C                 TO A LINEAR COMBINATION OF THE MASS INERTIA AND STIFFNESS
C                 COEFFICIENTS. ( CROSS MODAL COUPLING IS INCLUDED )
C
C
C   M             NUMBER OF FREQUENCIES, MASS AND MODE SHAPES
C
C
C                 THE FREQUENCIES(FREQ), GENERALIZED MASS(AMASS) AND
C                 MODE SHAPES(PHI) COME FROM THE EIGENVECTOR-EIGENVALUE
C                 ROUTINE TV-105W.
C
C   N             NUMBER OF RETAINED DEGREES OF FREEDOM
C   NF            NUMBER OF FREQUEUNCIES TO CALCULATE THE CPSD
C   G             STRUCTURAL DAMPING
C   ALAM          A DAMPING PROPORTIONALITY FACTOR PROP. TO STIFFNESS
C   CMU           A DAMPING PROPORTIONALITY FACTOR FOR DAMPING PROPORTIONAL
C                   TO MASS.
C
C***TAPE OUTPUT STORAGE - TAPE 16
C                  *****
C      MATRIX 1    *M-1* PARAMETER MATRIX(3X1)
C                  *K  *
C                  *N  *
C                  *****
C
C      MATRIX 2      0    PARAMETER K MATRIX USED FOR OFF-DIAG TEST
C                OR -1       ( M-1 BY 1 )
C
C
C      MATRIX 3     PHI(I,J)     I=1,M-1
C                                J=I,I+K
C
C
C
C
      DIMENSION DE(25,25), ED(25,25), DDEE(25,25), AMU(25), AMASS(25),
     1FREQ(25),OM4(25),X7(25),FREQ4(25),X8(25),SC1(25,25),
     2SC2(25,25),SMAT(3),B(16),PHI(100,25),PHIM(100),NSTO(3),KPARAM(24)
      COMMON /BLK1/ FREQ,AMASS
      COMMON /BLK2/ M,N,G,ALAM,CMU,K
      PI = 3.14159265
      NTAP1 = 10
      NTAP12 = 12
      NTAP16=16
      REWIND NTAP1
      REWIND NTAP12
      REWIND NTAP16
C
      DO 20 I=1,M
 20   AMU(I)=CMU+ALAM*FREQ(I)**2+G*FREQ(I)
C
C     THE FREQUENCIES AND MU ARE SCALED
      CALL SCALE( FREQ, M, SCAL )
      DO 25 I = 1,M
 25   AMU(I)  =  AMU(I)/SCAL
      MM=M-1
      NSTO(1)  =  MM
      NSTO(2)  =  K
      NSTO(3)  =  N
      NAME  =  0
      NMAT  =  0
      NFILE  =  0
      CALL WRTETP(NSTO,1,NAME,3,1,B,NFILE,NMAT,NTAP16,IRR)
      IF ( IRR .NE. 0 ) GO TO 9999
C***FORM PARAMETER K MATRIX TO TEST FOR NUMBER OF OFF-DIAGONAL TERMS
C         ARE DESIRED
C
      MK  =  M-K
      DO 30 I=1,MK
 30   KPARAM(I)  =  0
      MK  =  MK+1
      IF ( MK .GT. MM ) GO TO 50
      DO 40 I  =  MK,MM
 40   KPARAM(I)  =  -1
 50   NAME  =  0
      NMAT  =  0
      NFILE  =  0
      IF ( K .EQ. 1 ) GO TO 55
      GO TO 58
 55   KPARAM(M)  =  -1
      MM  =  M
 58   CONTINUE
      CALL WRTETP(KPARAM,1,NAME,MM,1,B,NFILE,NMAT,NTAP16,IRR)
      IF ( IRR .NE. 0 ) GO TO 9999
      IF ( K .EQ. 1 ) MM  =  M-1
      NAME  =  0
      NMAT=1
      NFILE  =  2
      CALL READTP(PHI,100,NAME,N,M,B,NFILE,NMAT,NTAP1,IRR)
      IF(IRR .NE. 0)GO TO 9998
      NAME  =  0
      NMAT=0
      NFILE  =  0
C     THE MODE SHAPES PHI ARE STORED ON TAPE
C****
      DO 90 II=1,MM
      J1  =  II
      ML  =  II+K
      IF( ML .GT. M ) ML  =  M
      DO 90 J = J1,ML
      DO 80 I=1,N
 80   PHIM(I)=PHI(I,J)
      CALL WRTETP(PHIM,1,NAME,N,1,B,NFILE,NMAT,NTAP16,IRR)
      IF ( IRR .NE. 0 ) GO TO 9999
 90   CONTINUE
C****
C****
C            THE ADMITTANCE INTEGRALS FOR OPTION 2 ARE FORMED AT M
C             NUMBER OF FREQUENCIEV.
C****
      DO 100 I=1,M
      FREQ4(I)=FREQ(I)**4
      X7(I)=AMU(I)**2-2.*FREQ(I)**2
 100  X8(I)=SQRT(4.*FREQ(I)**2-AMU(I)**2)*AMU(I)
C
C
      DO 130 I=1,M
      DO 120 J=1,M
      IF(I .NE. J)GO TO 110
      DE(I,J) = 0.
      ED(J,I) = 0.
      GO TO 120
 110  X2=FREQ(I)**2-FREQ(J)**2
      X3 = FREQ4(I) - FREQ4(J)
      X4 = AMU(J)*FREQ(I)**4
      X5 = AMU(I)**2 - AMU(J)**2
      X6 = FREQ(J)**4/FREQ(I)**4
      BMAT = (  AMU(J)*FREQ4(I)*FREQ(I)**2*X3 + X4*( FREQ4(I)*X7(J)-FREQ
     1         4(J)*X7(I) ) )/( FREQ4(I)*( X5-2.0*X2 )*( FREQ4(I)*X7(J)-
     2         FREQ4(J)*X7(I) ) - FREQ4(I)*X3**2  )
      AMAT = ( BMAT*FREQ4(I)*( X5-2.*X2 )-X4 )/X3
      CMAT = -AMAT*X6
      X = BMAT*ALOG(X6)/2.0 + ( AMAT-BMAT*X7(I)/2.0 )*PI/X8(I)
      X = X + ( CMAT + BMAT*X7(J)/2. )*PI/X8(J)
      DE(I,J) = X/( 2.*AMASS(I)*AMASS(J)   )
      ED(J,I) = DE(I,J)
 120  CONTINUE
 130  CONTINUE
C
C
      DO 3000 I =1,M
      DO 3000 J = 1,M
      IF( I .EQ. J ) GO TO 3000
 3000 DDEE(I,J) = (  PI*( AMU(I)*FREQ(J)**2+ AMU(J)*FREQ(I)**2 ) )/(
     1             AMASS(I)*AMASS(J)*( FREQ4(J) + AMU(I)**2*FREQ(J)**2 +
     2             AMU(I)*AMU(J)*FREQ(J)**2 + FREQ4(I) + AMU(I)*AMU(J)
     3             *FREQ(I)**2 + AMU(J)**2*FREQ(I)**2 - 2.0*FREQ(I)**2*
     4             FREQ(J)**2 ) )
      DO 4000 I=1,M
      DO 4000 J=1,M
      DE(I,J) = DE(I,J)/SCAL
      ED(J,I)=DE(I,J)
      IF( I .EQ. J ) GO TO 4000
C     THE SCALARS ARE RESCALED BY DIVIDING BY SCALE FACTOR CUBED.
      DDEE(I,J) = DDEE(I,J)/SCAL
 4000 CONTINUE
      MM=M-1
      DO 5000 I=1,MM
      M1=I+1
      DO 5000 J=M1,M
      SC1(I,J)=DE(I,J)-DE(J,I)
      SC2(I,J)=-SC1(I,J)
 5000 CONTINUE
      NAME = 0
      NMAT=0
      NFILE=0
      MM=M-1
C
C****
C   SMAT(1)   =   D(I)*D(J) + E(I)*E(J)     (INTEGRATE)
C   SMAT(2)   =   D(I)*E(J) - D(J)*E(I)     (INTEGRATE)
C   SMAT(3)   =   D(J)*E(I) - D(I)*E(J)     (INTEGRATE)
C
C
      NAME = 0
      NMAT = 0
      NFILE = 0
      DO 6000 I=1,MM
      M1=I+1
      ML = I + K
      IF( ML .GT. M ) ML = M
      DO 6000 J = M1,ML
      SMAT(1)=DDEE(I,J)
      SMAT(2)=SC1(I,J)
      SMAT(3)=SC2(I,J)
      CALL WRTETP(SMAT,1,NAME,3,1,B,NFILE,NMAT,NTAP12,IRR)
      IF ( IRR .NE. 0 ) GO TO 9999
 6000 CONTINUE
 54   CONTINUE
C
      DO 6050 I = 1,M
 6050 FREQ(I) = FREQ(I)*SCAL
      END FILE NTAP12
      END FILE NTAP16
      RETURN
 9998 WRITE(6,9010)IRR
      CALL EXIT
 9999 WRITE(6,9020)IRR
      CALL EXIT
      RETURN
 9010 FORMAT(28H ERROR IN READTP ERROR CODE=I5)
 9020 FORMAT(28H ERROR IN WRTETP ERROR CODE=I5)
      END
```

SUBROUTINE ADMIT3

```
$IBFTC ADMT3*  DECK
      SUBROUTINE ADMIT3
C
C                   *                                       *
C                  * A D M I T T A N C E    S C A L A R S *
C                 *                                         *
C                *    USED IN CALCULATING THE DEFLECTION      *
C                 *   RESPONSE CROSS POWER SPECTRAL DENSITY   *
C                  * ( CPSD )                                *
C                   *                                       *
C                    *       O P T I O N   3               *
C
C
C   OPTION 3            BROAD BAND EXCITATION, DAMPING COEFFICIENTS
C                       PROPORTIONAL TO A LINEAR COMBINATION OF THE
C                       MASS INERTIA AND STIFFNESS COEFFICIENTS.
C                        ( NO CROSS MODAL COUPLING )
C
C   D(I)                REAL FACTOR IN THE DIAGONAL ADMITTANCE SCALAR
C
C   E(I)                IMAGINARY FACTOR IN THE DIAGONAL ADMITTANCE SCALAR
C
C   N                   NUMBER OF RETAINED DEGREES OF FREEDOM
C   M                   NUMBER OF FREQUENCIES(FREQ),GENERALIZED MASS(AMASS)
C                       AND MODE SHAPES(PHI)
C   NF                  NUMBER OF FREQEUNCIES TO CALCULATE THE CPSD
C   G                   STRUCTURAL DAMPING
C   ALAM                A DAMPING PROPORTIONALITY FACTOR
C   CMU                 A DAMPING PROPORTIONALITY FACTOR
C
C
      DIMENSION FREQ(25), AMASS(25), OMEG(100), PHI(100,25),PHIM(100),
     1          AMU(25), D(25), E(25), DD(25), B(16), NSTO(3)
      COMMON /BLK1/ FREQ,AMASS,OMEG
      COMMON /BLK2/ M,N,G,ALAM,CMU,K,NF
      COMMON/BLK3/ FLG1,FLG2,FLG3,FLG4
      INTEGER FLG1,FLG2,FLG3,FLG4
      NTAP1 = 10
      NTAP2 = 2
      NTAP11 = 11
      REWIND NTAP1
      REWIND NTAP2
      REWIND NTAP11
      NAME = 0
      NMAT = 1
      NFILE = 2
C
C***                    THE MODE SHAPES ARE READ IN.
C
      CALL READTP(PHI,100,NAME,N,M,B,NFILE,NMAT,NTAP1,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      NSTO(1) = M
      NSTO(2) = M
      NSTO(3) = NF
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP( NSTO, 1, NAME,3,1,B,NFILE,NMAT,NTAP2,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      NAME = 0
      NMAT = 0
      NFILE = 0
      DO 20 J = 1,M
      DO 10 I = 1,N
   10 PHIM(I) = PHI(I,J)
      CALL WRTETP(PHIM,1,NAME,N,1,B,NFILE,NMAT,NTAP11,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
   20 CONTINUE
C
C
C
C
C****
C****
      WRITE(6,9000)
      NAME = 0
      NMAT = 0
      NFILE = 0
C                THE ADMITTANCE SCALARS FOR OPTION 3 ARE FORMED AT NF
C                NUMBER OF FREQUENCIES.
C****
C****
C
      DO 40 II=1,NF
      WRITE(6,9001) OMEG(II)
      DO 25 J=1,M
   25 AMU(J) = CMU + ALAM*FREQ(J)**2 + G*FREQ(J)**2/OMEG(II)
      DO 30 I=1,M
      DEN = AMASS(I)*( ( FREQ(I)**2-OMEG(II)**2 )**2 + OMEG(II)**2*(
     1 AMU(I) )**2 )
      D(I) = ( FREQ(I)**2-OMEG(II)**2 )/DEN
      E(I) = OMEG(II)*AMU(I)/DEN
   30 DD(I)=D(I)**2+E(I)**2
      WRITE(6,9002) ( I, DD(I),I=1,M )
      CALL WRTETP(DD,1,NAME,1,M,B,NFILE,NMAT,NTAP2,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
   40 CONTINUE
C
C
      END FILE NTAP2
      END FILE NTAP11
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H1,40X,32HADMITTANCE SCALARS ( D**2+E**2 )//// )
 9001 FORMAT(1H0,10HFREQUENCY=E14.7,9H(RAD/SEC)   )
 9002 FORMAT(1X,I5,5X,E14.7 )
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE ADMIT2

```
$IBFTC ADMT2*  DECK
      SUBROUTINE ADMIT2
C                *                                      *
C               * A D M I T T A N C E   S C A L A R S    *
C              *                                          *
C              *  USED IN CALCULATING THE DEFLECTION      *
C               * RESPONSE CROSS POWER SPECTRAL DENSITY  *
C                *  OR CPSD.                            *
C                 *                                    *
C
C
C
C
C  OPTION 2     BROAD BAND EXCITATION, DAMPING COEFFICIENTS PROPORTIONAL
C               TO A LINEAR COMBINATION OF THE MASS INERTIA AND STIFFNESS
C               COEFFICIENTS, ( CROSS MODAL COUPLING IS INCLUDED )
C
C
C
C
C  D(I)         ADMITTANCE SCALAR -   DIAGONAL MATRIX, REAL FACTOR IN
C                                     ADMITTANCE MATRIX.
C  E(I)         ADMITTANCE SCALAR -   DIAGONAL MATRIX, IMAGINARY FACTOR
C                                     IN ADMITTANCE MATRIX.
C
C
C               THE FREQUENCIES(FREQ), GENERALIZED MASS(AMASS) AND
C               MODE SHAPES(PHI) COME FROM THE EIGENVECTOR-EIGENVALUE
C               ROUTINE TV-105W.
C
C  N            NUMBER OF RETAINED DEGREES OF FREEDOM
C  NF           NUMBER OF FREQUEUNCIES TO CALCULATE THE CPSD
C  G            STRUCTURAL DAMPING
C  ALAM         A DAMPING PROPORTIONALITY FACTOR
C  CMU          A DAMPING PROPORTIONALITY FACTOR
C
C
      DIMENSION D(25),E(25),DD(25),OMEG(100),B(16),SC1(25,25),SC2(25,25)
     1          ,DDEE(25,25),SMAT(3),DE(25,25),ED(25,25),AMU(25),AMASS(
     2          25),FREQ(25),PHI(100,25),PHIM(100),NSTO(4),KPARAM(24)
      COMMON /BLK1/ FREQ,AMASS,OMEG
      COMMON /BLK2/ M,N,G,ALAM,CMU,K,NF
      NTAP1 = 10
      NTAP2 = 2
      NTAP16 = 16
      REWIND NTAP1
      REWIND NTAP2
      REWIND NTAP16
      MM = M-1
C
C***FORM PARAMETER MATRIX NSTO
      NSTO(1) = MM
      NSTO(2) = K
      NSTO(3) = N
      NSTO(4) = NF
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(NSTO,1,NAME,4,1,B,NFILE,NMAT,NTAP16,IRR)
      IF( IRR .NE. 0 ) GO TO 9999
C***FORM PARAMETER K MATRIX TO TEST FOR NUMBER OF OFF-DIAGONAL TERMS
      MK = M-K
      DO 10 I = 1,MK
   10 KPARAM(I) = 0
      MK = MK + 1
      IF ( MK .GT. MM ) GO TO 30
      DO 20 I = MK,MM
   20 KPARAM(I) = -1
   30 NAME = 0
      NMAT = 0
      NFILE = 0
      IF ( K .EQ. 1 ) GO TO 35
      GO TO 38
   35 KPARAM(M) = -1
      MM = M
   38 CONTINUE
      CALL WRTETP(KPARAM,1,NAME,MM,1,B,NFILE,NMAT,NTAP16,IRR)
      IF( IRR .NE. 0 ) GO TO 9999
      IF ( K .EQ. 1 ) MM = M-1
      NAME = 0
      NMAT =  1
      NFILE = 2
C
C                 THE MODE SHAPES ARE READ
C
      CALL READTP(PHI,100,NAME,N,M,B,NFILE,NMAT,NTAP1,IRR)
      IF( IRR .NE. 0 ) GO TO 9998
      NAME = 0
      NMAT = 0
      NFILE = 0
      DO 70 II = 1,MM
      J1 = II
      ML = II+K
      IF( ML .GT. M ) ML = M
      DO 70 J = J1,ML
      DO 60 I = 1,N
   60 PHIM(I) = PHI(I,J)
      CALL WRTETP( PHIM,1,NAME,N,1,B,NFILE,NMAT,NTAP16,IRR )
      IF ( IRR .NE. 0 ) GO TO 9999
   70 CONTINUE
      END FILE NTAP16
C
C****
C                 THE ADMITTANCE SCALARS FOR OPTION 2 ARE FORMED
C   SMAT(1)  =  D(I)*D(J) + E(I)*E(J)
C   SMAT(2)  =  D(I)*E(J) - D(J)*E(I)
C   SMAT(3)  =  D(J)*E(I) - D(I)*E(J)
C
C
      END FILE NTAP2
C
      DO 1000 II=1,NF
      DO 100 J=1,M
  100 AMU(J)=CMU+ALAM*FREQ(J)**2+G*FREQ(J)**2/OMEG(II)
C
      DO 200 I=1,M
      DEN = AMASS(I)*( ( FREQ(I)**2-OMEG(II)**2 )**2 + OMEG(II)**2*(AMU
     1      (I) )**2 )
      D(I) = ( FREQ(I)**2-OMEG(II)**2 )/DEN
  200 E(I)=OMEG(II)*AMU(I)/DEN
C
      DO 300 I=1,M
      DO 300 J=1,M
      DE(I,J)=D(I)*E(J)
      ED(J,I)=DE(I,J)
  300 DDEE(I,J)=D(I)*D(J)+E(I)*E(J)
C
      WRITE(6,9000)
      WRITE(6,9001)
C
      DO 4100 I = 1,M
      WRITE(6,9002)I
      WRITE(6,9003) ( J,DE(I,J),DDEE(I,J),J=1,M)
      WRITE(6,9004)
 4100 CONTINUE
C
      DO 400 I=1,MM
      M1=I+1
      DO 400 J=M1,M
      SC1(I,J) = DE(I,J)-DE(J,I)
  400 SC2(I,J)=-SC1(I,J)
      NAME = 0
      NMAT = 0
      NFILE = 0
      DO 500 I=1,MM
      M1=I+1
      ML = I + K
      IF( ML .GT. M ) ML = M
      DO 500 J = M1,ML
      SMAT(1) = DDEE(I,J)
      SMAT(2) = SC1(I,J)
      SMAT(3) = SC2(I,J)
      CALL WRTETP(SMAT,1,NAME,3,1,B,NFILE,NMAT,NTAP2,IRR)
      IF(IRR .NE. 0)GO TO 9999
  500 CONTINUE
      END FILE NTAP2
 1000 CONTINUE
C
C
C
      END FILE 2
      RETURN
 9998 WRITE(6,9010)IRR
      CALL EXIT
 9999 WRITE(6,9020)IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H1,50X,21HADMITTANCE SCALARS   ////)
 9001 FORMAT(1H0,10X,9HD(I)*E(J),20X,22HD(I)*D(J) + E(I)*E(J)   ///)
 9002 FORMAT(1H0,3H I=I3)
 9003 FORMAT(7X,I3,1X,E14.7,10X,E14.7)
 9004 FORMAT(1H0)
 9010 FORMAT( 28H ERROR IN READTP-ERROR CODE=I5 )
 9020 FORMAT(28H ERROR IN WRTETP ERROR CODE=I5)
      END
```

SUBROUTINE CQCPSD

```
$IBFTC CQCPS*  DECK
      SUBROUTINE CQCPSD
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF
         DIMENSION SMAT(3),CFW(90,90),QFW(90,90),B(16)
C***ROUTINE THAT STORES THE EXCITATIONS FOR THE CROSS POWER SPECTRAL
C           DENSITY ON TAPE
C
C    FSF     FORWARD SPACE FILES
C            CALLING SEQUENCE        CALL FSF(NFILE,NTAP18,LERROR)
C                                 WHERE
C                                        NFILE=NO OF FILES TO FORWARD SPACE
C                                       NTAP18=LOGICAL TAPE UNIT
C                                       LERROR= 0     SUCCESS
C                                           NON-ZERO NO OF UNSPACED FILES
C
C    BSF     BACKSPACE FILES            SAME CALLING SEQUENCE AS FSF
C
      NTAP2 = 2
      NTAP15= 15
      NTAP18 = 14
      REWIND NTAP2
      REWIND NTAP15
      REWIND NTAP18
      IQ = 0
C
      MM = M-1
      DO 600 IJ = 1,2
      IF ( IJ .EQ. 2 ) IQ = 1
C***LOOP NO OF FREQUENCIES
      DO 500 II = 1,NF
      NFILE = 1
      CALL FSF( NFILE,NTAP2,LERROR )
      DO 200 I = 1,MM
      M1 = I + 1
      ML = I+K
      IF( ML .GT. M ) ML = M
      DO 200 J = M1,ML
      NAME = 0
      NMAT = 0
      NFILE = 0
C***READ IN THE ADMITTANCE SCALARS
      CALL READTP(SMAT,1,NAME,NR,NC,B,NFILE,NMAT,NTAP2,IRR)
      IF( IRR .NE. 0 ) GO TO 9998
C***READ THE CO-POWER SPECTRAL DENSITY(CFW)
      NAME = 0
      NMAT = 0
      NFILE = 1
      CALL READTP(CFW,90,NAME,N,N,B,NFILE,NMAT,NTAP18,IRR)
      IF( IRR .NE. 0 ) GO TO 9998
C***READ IN THE QUAD-POWER SPECORAL DENSITY(QFW)
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL READTP(QFW,90,NAME,N,N,B,NFILE,NMAT,NTAP18,IRR)
      IF( IRR .NE. 0 ) GO TO 9998
      IF ( IQ .NE. 0 ) GO TO 54
C
```

```
C
C***FORM THE EXCITATION MATRIX TO BE STORED ON TAPE 15
      DO 50 K1 = 1,N
      DO 50 L1 = 1,N
 50   CFW(K1,L1) = CFW(K1,L1)*SMAT(1) + QFW(K1,L1)*SMAT(2)
C
C
      GO TO 80
 54   CONTINUE
C***READ THE QUAD-POWER SPECTRAL DENSITY(QFW)
      DO 60 K1 = 1,N
      DO 60 L1 = 1,N
 60   CFW(K1,L1) = CFW(K1,L1)*SMAT(3) + QFW(K1,L1)*SMAT(1)
 80   CONTINUE
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(CFW,90,NAME,N,N,B,NFILE,NMAT,NTAP15,IRR)
      IF( IRR .NE. 0 ) GO TO 9999
      NFILE = 1
      CALL BSF(NFILE,NTAP18,LERROR)
      IF( LERROR .NE. 0 ) GO TO 9997
 200  CONTINUE
C
C
      IF ( I .EQ. MM ) GO TO 500
      NFILE = 1
      CALL FSF(NFILE,NTAP18,LERROR )
 500  CONTINUE
C
C
      REWIND NTAP2
      REWIND NTAP18
 600  CONTINUE
      END FILE NTAP15
C
      RETURN
C
C
 9997 WRITE(6,9005) LERROR
      CALL EXIT
 9998 WRITE(6,9010) IRR
      CALL EXIT
 9999 WRITE(6,9020) IRR
      CALL EXIT
      RETURN
 9005 FORMAT(67H ERROR IN BSF ROUTINE(BACKSPACE FILES)-NUMBER OF UNSPACE
     1D FILES IS I5 )
 9010 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9020 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE SUM3

```
$IBFTC SUM3*    DECK
      SUBROUTINE SUM3( ITP1,ITP2,ITP3)
C
C
C                       CROSS MODAL EFFECT OF CROSS-PSD MATRICES WILL
C                         BE SUMMED AT EACH FREQUENCY FOR REAL AND
C                         IMAGINARY PART.
C
C
C
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON /BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      DIMENSION AMAT(90,90),BMAT(90,90),B(16),IPARAM(2)
      DIMENSION FREQ(25),AMASS(25),OMEGA(100)
      REWIND ITP1
      REWIND ITP2
      REWIND ITP3
      IPARAM(1) = NPLATE + 2*NBEAMS
      IPARAM(2) = 2*NF
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(IPARAM,1,NAME,1,2,B,NFILE,NMAT,ITP3,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      NAME = 0
      NFILE = 0
C
      DO 500 II = 1,NF
      WRITE(6,9000) OMEGA(II)
      IF ( II .EQ. 1  ) GO TO 10
      NMAT = 0
      GO TO 20
 10   NMAT = 1
 20   CALL READTP(AMAT,90,NAME,N,N,B,NFILE,NMAT,ITP1,IRR)
      CALL READTP(BMAT,90,NAME,N,N,B,NFILE,NMAT,ITP2,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      DO 50 I = 1,N
      DO 50 J = 1,N
 50   AMAT(I,J) = AMAT(I,J) + BMAT(I,J)
      DO 450 I = 1,N
      WRITE(6,9001)I,(AMAT(I,J),J=1,N)
 450  CONTINUE
C
      NMAT = 0
      CALL WRTETP(AMAT,90,NAME,N,N,B,NFILE,NMAT,ITP3,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
 500  CONTINUE
C
C
      DO 600 II = 1,NF
      WRITE(6,9002) OMEGA(II)
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL READTP (AMAT,90,NAME,N,N,B,NFILE,NMAT,ITP2,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(AMAT,90,NAME,N,N,B,NFILE,NMAT,ITP3,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      DO 550 I = 1,N
      WRITE(6,9001)I,(AMAT(I,J),J=1,N)
  550 CONTINUE
  600 CONTINUE
C
      END FILE ITP3
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H0,33HDEFLECTION CO-POWER, FREQUENCY = E14.7,11H  (RAD/SEC
     1)  //)
 9001 FORMAT(1H0,I5,1P7E16.6/(E22.6,6E16.6) )
 9002 FORMAT(1H0,35HDEFLECTION QUAD-POWER, FREQUENCY = E14.7,11H  (RAD/S
     1EC)  //)
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

SUBROUTINE PRINTE

```
$IBFTC PRNTE*  DECK
      SUBROUTINE PRINTE
C
C
C                         THE STRESS-PSD MATRICES ARE PRINTED FOR
C                           OPTION 2 IN THIS SUBROUTINE.
C
C
C
      COMMON/BLK1/FREQ,AMASS,OMEGA
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      COMMON/BLK3/FLG1,FLG2,FLG3,FLG4
      INTEGER FLG1,FLG2,FLG3,FLG4
      DIMENSION FREQ(25),AMASS(25),OMEGA(100),S(8,8),B(16),SB(6,6)
      NTAPE = 15
      REWIND NTAPE
      NAME = 0
      NMAT = 0
      NFILE = 0
C
C***IF NPLATE EQUALS 0 - SKIP PLATES PRINTOUT
      IF ( NPLATE .EQ. 0 ) GO TO 200
C
C
C
      DO 100 III = 1,NPLATE
      WRITE(6,9000)
C
      DO 60 II = 1,2
      IF ( II .EQ. 2 ) GO TO 10
      WRITE(6,9001)
      GO TO 20
 10   WRITE(6,9002)
C
 20   DO 50 IJ = 1,NF
      WRITE(6,9003) OMEGA(IJ)
      CALL READTP(S,8,NAME,NR,NC,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      DO 15 I = 1,8
      WRITE(6,9004)I,(S(I,J),J=1,8)
 15   CONTINUE
 50   CONTINUE
C
 60   CONTINUE
C
C
 100  CONTINUE
C
C
C
C
C***IF NBEAMS EQUALS 0 - SKIP BEAMS PRINTOUT
 200  IF ( NBEAMS .EQ. 0 ) RETURN
C
C
      DO 1000 III = 1,NBEAMS
      WRITE(6,9005)III
```

```
C
      DO 999 II = 1,2
      WRITE(6,9006)  II
C
      DO 998 IJ = 1,2
      IF ( IJ .EQ. 2 ) GO TO 70
      WRITE(6,9007)
      GO TO 80
 70   WRITE(6,9008)
 80   DO 995 I1 = 1,NF
      WRITE(6,9009) OMEGA(I1)
      CALL READTP(SB,6,NAME,NR,NC,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
C
      DO 90 I = 1,6
      WRITE(6,9010)I,(SB(I,J),J=1,6)
 90   CONTINUE
C
 995  CONTINUE
C
 998  CONTINUE
C
C
 999  CONTINUE
C
C
 1000 CONTINUE
C
C
C
C
      REWIND NTAPE
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H0,6HPLATE I3)
 9001 FORMAT(10X,9HREAL PART///)
 9002 FORMAT(10X,9HIMAG PART///)
 9003 FORMAT(20X,10HFREQUENCY=E14.7)
 9004 FORMAT(1H0,14X,I5,8E14.5/(20X,8E14.5) )
 9005 FORMAT(1H0,6H BEAM I3///)
 9006 FORMAT(10X,4HEND I3//)
 9007 FORMAT(1H0,17X,10HREAL PART I5//)
 9008 FORMAT(1H0,17X,10HIMAG PART I5//)
 9009 FORMAT(1H0,30X,10HFREQUENCY=E14.7///)
 9010 FORMAT(1H0,30X,I5,6E14.5/(36X,6E14.5) )
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
      END
```

SUBROUTINE DSECM3

```
$IBFTC DSECM*  DECK
      SUBROUTINE DSECM3
C                         THE DEFLECTION SECOND SPECTRAL MOMENTS ARE
C                           FORMED FOR OPTION 3.
C                           THE DEFLECTION CO-VARIANCE MATRICES ARE MULTIPLIED
C                           BY FREQ**2 AND SUMMED OVER M NORMAL MODES.
      COMMON/BLK1/FREQ
      COMMON/BLK2/M,N,G,ALAM,CMU,K,NF,NPLATE,NBEAMS
      DIMENSION AMAT(90,90 ),B(16),SUM(90,90),FREQ(25),IPARAM(2)
      NTAPE = 8
      REWIND NTAPE
      DO 10 I = 1,N
      DO 10 J = 1,N
 10   SUM(I,J) = 0.
      NAME = 0
      NMAT = 0
      NFILE = 0
      DO 100 II = 1,M
      CALL READTP(AMAT,90,NAME,N,N,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9985
      DO 50 I = 1,N
      DO 50 J = 1,N
 50   SUM(I,J) = SUM(I,J) + AMAT(I,J)*FREQ(II)**2
 100  CONTINUE
      NTAPE = 3
      REWIND NTAPE
      NO = 1
      NAME = 0
      NMAT = 0
      NFILE = 0
C***FORM PARAMETER MATRIX IPARAM
      IPARAM(1) = NPLATE + 2*NBEAMS
      IPARAM(2) = NO
      CALL WRTETP(IPARAM,1,NAME,1,2,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      NAME = 0
      NMAT = 0
      NFILE = 0
      CALL WRTETP(SUM,90,NAME,N,N,B,NFILE,NMAT,NTAPE,IRR)
      IF ( IRR .NE. 0 ) GO TO 9986
      WRITE(6,9000)
      DO 200 I = 1,N
      WRITE(6,9001)I,(SUM(I,J),J=1,N)
 200  CONTINUE
      END FILE NTAPE
      RETURN
 9985 WRITE(6,9990) IRR
      CALL EXIT
 9986 WRITE(6,9991) IRR
      CALL EXIT
      RETURN
 9000 FORMAT(1H1,30X,53HDEFLECTION SECOND SPECTRAL MOMENT MATRIX (REAL P
     1ART)  ///)
 9001 FORMAT(1H0,I5,1P7E16.6/(E22.6,6E16.6) )
 9990 FORMAT(28H ERROR IN READTP-ERROR CODE=I5)
 9991 FORMAT(28H ERROR IN WRTETP-ERROR CODE=I5)
      END
```

```
8150B                                                   0B          LOAD + EXECUTE
              8350B                                     0B          PARTITION CORE
              -8000000B                                 0B          REW 8(SCRATCH)
              -11000000B                                0B          REW 11(DIAG SCALARS)
              -17000000B                                0B          REW 17(CFW-NXN)
11000000B                   8000B                       0B          READ PARAMETER M
11000000B                   8004B                       0B          READ DIAG SCALARS
11000000B                   8032B                       0B          READ MODES(PHI)
17000000B                   1B                          0B          READ CFW
8032B         1B            2B                          8B          PHI(TRANSP)*CFW
2B            8032B         1B                          6B          PHI(TRANSP)*CFW*PHI
8007B                       8136B                       27B         READY NEXT  SCALAR
-1011B                                    1B            27B
8136B         1B            8138B                       5B          SCALAR MULT
8141B         8032B         2B                          5B          SCALAR MULT
2B            8032B         3B                          7B          POST MULT BY PHI(TR)
3B                          8000000B                    0B          STORE ON TAPE 8
-10B                                      8003B         0B          CYCLE M TIMES
              8000000B                                  0B          WRITE EOF ON 8
                                                                                          +

8010B                                                   0B          LOAD + EXECUTE
              8200B                                     0B          PARTITION CORE
              -3000000B                                 0B          REW 3 (JD)
              -10000000B                                0B          REW 10 (STRESSES)
              -15000000B                                0B          REW 15
3000000B                    8000B                       0B          READ PARAM(CYCLE CNT)
3000000B                    1B                          0B          READ JD
              10001000B                                 0B          SKIP 1 EOF ON 10
10000000B                   2B                          0B          READ STRESSES(S)
2B            1B            3B                          6B          (S)*(JD)
3B            2B            4B                          7B          (S)*(JD)*(S)TRANSP
4B                          15000000B                   0B          STORE ON TAPE 15
-4B                                       8003B         0B          CYCLE
              15000000B                                 0B          WRITE EOF ON 15
                                                                                          +

8100B                                                   0B          LOAD + EXECUTE
              8200B                                     0B          PARTITION CORE
              -3000000B                                 0B          REW 3 (JD)
              -10000000B                                0B          REW 10 (STRESSES)
              -15000000B                                0B          REW 15
3000000B                    8000B                       0B          READ PARAM(CYCLE CNT)
3000000B                    1B                          0B          READ JD
              10001000B                                 0B          SKIP 1 EOF ON 10
10000000B                   2B                          0B          READ STRESSES(S)
2B            1B            3B                          6B          (S)*(JD)
3B            2B            4B                          7B          (S)*(JD)*(S)TRANSP
4B                          15000000B                   0B          STORE ON TAPE 15
-4B                                       8003B         0B          CYCLE
              15000000B                                 0B          WRITE EOF ON 15
                                                                                          +

8150B                                                   0B          LOAD + EXECUTE
              8350B                                     0B          PARTITION CORE
              -8000000B                                 0B          REW 8 (SCRATCH)
              -2000000B                                 0B          REW 2 (SCALARS)
              -11000000B                                0B          REW 11(MODES)
              -17000000B                                0B          REW 17(CFW)
```

```
2000000B                      8000B                         0B          READ M.NF
2000000B                      8006B                         0B          READ SCALARS
               -11000000B                                   0B          REW 11(MODES)
               17001000B                                    0B          SKIP EOF ON 17
11000000B                     8034B                         0B          READ MODES(PHI)
17000000B                     1B                            0B          READ CFW
8034B          1B             2B                            8B          PHI(TRANSP)*CFW
2B             8034B          1B                            6B          PHI(TRANSP)*CFW*PHI
8009B                         8137B                         27B         READY NEXT SCALAR
-1011B                                       1B             27B
8137B          1B             8140B                         5B          SCALAR MULT
8143B          8034B          2B                            5B          SCALAR MULT
8034B                         3B                            9B          PHI(TRANSP)
2B             3B             4B                            6B          MULT
               -17001000B                                   0B          BACKSPACE 1 EOF
4B                            8000000B                      0B          STORE ON TAPE 8
-12B                                         8003B          0B          CYCLE M TIMES
-1091B                                       8003B          33B         RESTORE SCALAR CELLS
-17B                                         8005B          0B          CYCLE NFREQ TIMES
                                                                                              +

8010B                                                       0B          LOAD + EXECUTE
               8200B                                        0B          PARTITION CORE
               -3000000B                                    0B          REW 3 (JD)
               -15000000B                                   0B          REW 15
3000000B                      8000B                         0B          READ PARAM(CYCLE CNT)
               -10000000B                                   0B          REW 10 (STRESSES)
3000000B                      1B                            0B          READ JD
               10001000B                                    0B          SKIP 1 EOF ON 10
10000000B                     2B                            0B          READ STRESSES(S)
2B             1B             3B                            6B          (S)*(JD)
3B             2B             4B                            7B          (S)*(JD)*(S)TRANSP
4B                            15000000B                     0B          STORE ON TAPE 15
-4B                                          8003B          0B          CYCLE
-8B                                          8004B          0B          CYCLE NFREQ
               15000000B                                    0B          WRITE EOF ON 15
                                                                                              +


8150B                                                       0B          LOAD + EXECUTE
               8350B                                        0B          PARTITION CORE
               -8000000B                                    0B          REW 8(SCRATCH)
               -11000000B                                   0B          REW 11(DIAG SCALARS)
               -17000000B                                   0B          REW 17(CFW-NXN)
11000000B                     8000B                         0B          READ PARAMETER M
11000000B                     8004B                         0B          READ DIAG SCALARS
11000000B                     8032B                         0B          READ MODES(PHI)
17000000B                     1B                            0B          READ CFW
8032B          1B             2B                            8B          PHI(TRANSP)*CFW
2B             8032B          1B                            6B          PHI(TRANSP)*CFW*PHI
8007B                         8136B                         27B         READY NEXT  SCALAR
-1011B                                       1B             27B
8136B          1B             8138B                         5B          SCALAR MULT
8141B          8032B          2B                            5B          SCALAR MULT
2B             8032B          3B                            7B          POST MULT BY PHI(TR)
3B                            8000000B                      0B          STORE ON TAPE 8
-10B                                         8003B          0B          CYCLE M TIMES
               8000000B                                     0B          WRITE EOF ON 8
                                                                                              +
8350B                                   0B        LOAD + EXECUTE
          8750B                         0B        PARTITION CORE
          -8000000B                     0B        REW 8(SCRATCH)
          -15000000B                    0B        REW 15(EXCITATIONS)
          -16000000B                    0B        REW 16(MODE SHAPES)
16000000B           8000B               0B        READ M-1.K.N
16000000B           8007B               0B        READ K TERMS
8004B               8006B               27B       COPY K
16000000B           8041B               0B        READ PHI(I)
8247B                         103B      29B       CLEAR 103 CELLS
8248B                         1B        27B       SET ROW DIM
8249B                         8005B     27B       SET COL DIM
8006B                         8010B     27B       READY NEXT K
-1014B                        1B        27B
16000000B           8144B               0B        READ PHI(J)
15000000B           1B                  0B        READ CQ(I.J) MATRIX
8041B     1B        2B                  8B        PHI(I)TRANSP*CQ(I.J)
2B        8144B     3B                  6B        MULT BY PHI(J)
8144B               4B                  9B        PHI(J)TRANSP
3B        4B        8247B               30B       MULT + ADD
-6B                           8006B     0B        CYCLE J=I+1.I+K
8041B     8247B     1B                  6B        MULT SUM J  BY PHI(I)
1B                  8000000B            0B        STORE SUM OF J ON 8
-15B                          8003B     0B        CYCLE I=1.M-1
          -16000000B                    0B        REW 16
          16000002B                     0B        SKIP 2 MATRICES ON 16
-1144B                        8003B     33B       REDUCE K LOC
-20B                          2B        0B        CYCLE BACK FOR IMAG
          8000000B                      0B        WRITE EOF ON 8
                                                                       +

8010B                                   0B        LOAD + EXECUTE
          8200B                         0B        PARTITION CORE
          -3000000B                     0B        REW 3 (JD)
          -15000000B                    0B        REW 15
3000000B            8000B               0B        READ PARAM(CYCLE CNT)
          -10000000B                    0B        REW 10 (STRESSES)
3000000B            1B                  0B        READ JD
          10001000B                     0B        SKIP 1 EOF ON 10
10000000B           2B                  0B        READ STRESSES(S)
2B        1B        3B                  6B        (S)*(JD)
3B        2B        4B                  7B        (S)*(JD)*(S)TRANSP
4B                  15000000B           0B        STORE ON TAPE 15
-4B                           8003B     0B        CYCLE
-8B                           8004B     0B        CYCLE
          15000000B                     0B        WRITE EOF ON 15
                                                                       +

8150B                                   0B        LOAD + EXECUTE
          8350B                         0B        PARTITION CORE
          -8000000B                     0B        REW 8(SCRATCH)
          -11000000B                    0B        REW 11(DIAG SCALARS)
          -17000000B                    0B        REW 17(CFW-NXN)
11000000B           8000B               0B        READ PARAMETER M
11000000B           8004B               0B        READ DIAG SCALARS
11000000B           8032B               0B        READ MODES(PHI)
17000000B           1B                  0B        READ CFW
8032B     1B        2B                  8B        PHI(TRANSP)*CFW
2B        8032B     1B                  6B        PHI(TRANSP)*CFW*PHI
8007B               8136B               27B       READY NEXT  SCALAR
```

```
-1011B                              1B        27B
8136B       1B          8138B                 5B        SCALAR MULT
8141B       8032B       2B                    5B        SCALAR MULT
2B          8032B       3B                    7B        POST MULT BY PHI(TR)
3B                      8000000B              0B        STORE ON TAPE 8
-10B                                8003B     0B        CYCLE M TIMES
            8000000B                          0B        WRITE EOF ON 8
                                                                                +


8350B                                         0B        LOAD + EXECUTE
            8750B                             0B        PARTITION CORE
            -8000000B                         0B        REW 8(SCRATCH)
            -15000000B                        0B        REW 15(EXCITATIONS)
            -16000000B                        0B        REW 16(MODE SHAPES)
16000000B               8000B                 0B        READ M-1,K,N
16000000B               8007B                 0B        READ K TERMS
8004B                   8006B                 27B       COPY K
16000000B               8041B                 0B        READ PHI(I)
8247B                               103B      29B       CLEAR 103 CELLS
8248B                               1B        27B       SET ROW DIM
8249B                               8005B     27B       SET COL DIM
8006B                               8010B     27B       READY NEXT K
-1014B                              1B        27B
16000000B               8144B                 0B        READ PHI(J)
15000000B               1B                    0B        READ CQ(I,J) MATRIX
8041B       1B          2B                    8B        PHI(I)TRANSP*CQ(I,J)
2B          8144B       3B                    6B        MULT BY PHI(J)
8144B                   4B                    9B        PHI(J)TRANSP
3B          4B          8247B                 30B       MULT + ADD
-6B                                 8006B     0B        CYCLE J=I+1,I+K
8041B       8247B       1B                    6B        MULT SUM J  BY PHI(I)
1B                      8000000B              0B        STORE SUM OF J ON 8
-15B                                8003B     0B        CYCLE I=1,M-1
            -16000000B                        0B        REW 16
            16000002B                         0B        SKIP 2 MATRICES ON 16
-1144B                              8003B     33B       REDUCE K LOC
-20B                                2B        0B        CYCLE BACK FOR IMAG
            8000000B                          0B        WRITE EOF ON 8
                                                                                +


8010B                                         0B        LOAD + EXECUTE
            8200B                             0B        PARTITION CORE
            -3000000B                         0B        REW 3 (JD)
            -15000000B                        0B        REW 15
3000000B                8000B                 0B        READ PARAM(CYCLE CNT)
            -10000000B                        0B        REW 10 (STRESSES)
3000000B                1B                    0B        READ JD
            10001000B                         0B        SKIP 1 EOF ON 10
10000000B               2B                    0B        READ STRESSES(S)
2B          1B          3B                    6B        (S)*(JD)
3B          2B          4B                    7B        (S)*(JD)*(S)TRANSP
4B                      15000000B             0B        STORE ON TAPE 15
-4B                                 8003B     0B        CYCLE
-8B                                 8004B     0B        CYCLE NF TIMES
            15000000B                         0B        WRITE EOF ON 15
                                                                                +


8150B                                         0B        LOAD + EXECUTE
            8350B                             0B        PARTITION CORE
            -8000000B                         0B      REW 8 (SCRATCH)
            -2000000B                         0B      REW 2 (SCALARS)
            -11000000B                        0B      REW 11(MODES)
            -17000000B                        0B      REW 17(CFW)
2000000B                8000B                 0B      READ M,NF
2000000B                8006B                 0B      READ SCALARS
            -11000000B                        0B      REW 11(MODES)
            17001000B                         0B      SKIP EOF ON 17
11000000B               8034B                 0B      READ MODES(PHI)
17000000B               1B                    0B      READ CFW
8034B       1B          2B                    8B      PHI(TRANSP)*CFW
2B          8034B       1B                    6B      PHI(TRANSP)*CFW*PHI
8009B                   8137B                 27B     READY NEXT SCALAR
-1011B                              1B        27B
8137B       1B          8140B                 5B      SCALAR MULT
8143B       8034B       2B                    5B      SCALAR MULT
8034B                   3B                    9B      PHI(TRANSP)
2B          3B          4B                    6B      MULT
            -17001000B                        0B      BACKSPACE 1 EOF
4B                      8000000B              0B      STORE ON TAPE 8
-12B                                8003B     0B      CYCLE M TIMES
-1091B                              8003B     33B     RESTORE SCALAR CELLS
-17B                                8005B     0B      CYCLE NFREQ TIMES
                                                                           +

8350B                                         0B      LOAD AND EXECUTE
            8750B                             0B      PARTITION CORE
            -8000000B                         0B      REW 8(SCRATCH)
            -15000000B                        0B      REW 15(EXCITATIONS)
            -16000000B                        0B      REW 16(MODE SHAPES)
16000000B               8000B                 0B      READ M-1,K,N,NFREQ
16000000B               8008B                 0B      READ K OFF-DIAG TERMS
8004B                   8007B                 27B     COPY K
16000000B               8035B                 0B      READ PHI(I)
8241B                               103B      29B     CLEAR 103 CELLS
8242B                               1B        27B     ADD ROW DIM
8243B                               8005B     27B     ADD COL DIM
8007B                               8011B     27B     READY NEXT K
-1014B                              1B        27B
16000000B               8138B                 0B      READ PHI(J)
15000000B               1B                    0B      READ C(I,J) MATRIX
8035B       1B          2B                    8B      PHI(I)TRANSP*CQ(I,J)
2B          8138B       3B                    6B      MULT BY PHI(J)
8138B                   4B                    9B      PHI(J)TRANSP
3B          4B          8241B                 30B     MULT + ADD
-6B                                 8007B     0B      CYCLE J=I+1,I+K
8035B       8241B       1B                    6B      MULT BY PHI(I)
1B                      8000000B              0B      STORE SUM OF J ON 8
-15B                                8003B     0B      CYCLE I = 1,M-1
            -16000000B                        0B      REW 16
            16000002B                         0B      SKIP 2 MATRICES ON 16
-1144B                              8003B     33B     RESET K LOC
-20B                                8006B     0B      CYCLE NF TIMES
-21B                                2B        0B      CYCLE REAL,IMAG
            8000000B                          0B      WRITE EOF ON 8
                                                                           +

8010B                                         0B      LOAD + EXECUTE
            8200B                             0B      PARTITION CORE
            -8000000B                         0B      REW 8 (PARAM-CPSD)
            -10000000B                          0B      REW 10 (STRESSES)
            -15000000B                          0B      REW 15
8000000B                8000B                   0B      READ PARAM
            -8000000B                           0B      REW 8
            10001000B                           0B      SKIP 1 EOF ON 10
10000000B               1B                      0B      READ STRESS
            8000001B                            0B      SKIP 1 MATRIX
8000000B                2B                      0B      READ CPSD
1B          2B          3B                      6B      S*CPSD
3B          1B          4B                      7B      S*CPSD*S TRANP
4B                      15000000B               0B      STORE ON TAPE 15
-4B                                 8004B       0B      CYCLE REAL,IMAG
            -8000000B                           0B      REW 8
-8B                                 8003B       0B      CYCLE STRESSES
            15000000B                           0B      WRITE EOF ON 15
                                                                            +


8010B                                           0B      LOAD + EXECUTE
            -12000000B                          0B      REW 12 (OUTPUT)
            -14000000B                          0B      REW 14 (PARAM)
            -15000000B                          0B      REW 15 (A-REAL )
            -16000000B                          0B      REW 16 ( B-IMAG )
            12000000B                           0B      WRITE EOF ON 12
            8200B                               0B      PARTITION CORE
14000000B               8000B                   0B      READ PARAM
15000000B               1B                      0B      READ A
1B                      1B                      18B     A(INVERSE)
16000000B               2B                      0B      READ B
1B          2B          3B                      6B      A(INV)*B
2B          3B          1B                      6B      B*A(INV)*B
15000000B               2B                      0B      READ A
2B          1B          2B                      1B      A+B*A(INV)*B
3B                      1B                      0B      COPY A(INV)*B
2B                      2B                      18B     (A+B*A(INV)*B) INV
1B          2B          3B                      6B      MULT - IMAG
2B                      12000000B               0B      SAVE J - REAL
3B                      12000000B               0B      SAVE L - IMAG
            12000000B                           0B      WRITE EOF ON 12
-13B                                8005B       0B      CYCLE NF TIMES
                                                                            +

8010B                                           0B      LOAD + EXECUTE
            8500B                               0B      PARTITION CORE
            -3000000B                           0B      REW 3 -SCRATCH
            -12000000B                          0B      REW 12 (L AND J)
            -14000000B                          0B      REW 14 ( PARAM )
            -15000000B                          0B      REW 15 (OUT-REAL)
            -16000000B                          0B      REW 16 ( OUT-IMAG)
            -17000000B                          0B      REW 17-QF AND CF MAT.
14000000B               8000B                   0B      READ PARAM
            12001000B                           0B      SKIP 1 EOF
            17001000B                           0B      SKIP PAST 1 EOF
12000000B               1B                      0B      READ L MATRIX
17000000B               2B                      0B      READ QF MATRIX
2B          1B          3B                      6B      MULT QF*L
3B                      1B                      0B      COPY
17000000B               2B                      0B      READ CF MATRIX
12000000B               3B                      0B      READ J MATRIX
2B          3B          1B                      30B     CF*J + QF*L = X
```

```
3B        1B        2B                  6B        J*X
2B                  3000000B            0B        STORE ON TAPE 3
          -12001000B                    0B        BACKSPACE 1 EOF
12000000B           2B                  0B        READ L MATRIX
2B        1B        3B                  6B        MULT L*X MATRIX
3B                  3000000B            0B        STORE ON TAPE 3
          3000000B                      0B        WRITE EOF ON 3
12000000B           1B                  0B        READ J MATRIX
          -17001000B                    0B        BACKSPACE PAST 1 EOF
17000000B           2B                  0B        READ QF MATRIX
2B        1B        3B                  6B        MULT QF*J
3B                  1B                  0B        COPY
1B        1B        2B                  1B        ADD QF*J + QF*J=Y
1B        2B        1B                  2B        SUBT QF*J - Y = -QF*J
17000000B           2B                  0B        READ CF MATRIX
          -12001000B                    0B        BACKSPACE 1 EOF
12000000B           3B                  0B        READ L MATRIX
2B        3B        1B                  30B       CF*L - QF*J = Z
3B        1B        2B                  6B        MULT L*Z
          -3000000B                     0B        REW 3
3000000B            3B                  0B        READ REAL
2B        3B        2B                  1B        TOTAL REAL
2B                  15000000B           0B        STORE REAL
12000000B           2B                  0B        READ J MATRIX
2B        1B        3B                  6B        MULT J*Z
3000000B            1B                  0B        READ IMAG
1B        3B        1B                  2B        IMAG
1B                  16000000B           0B        STORE IMAG
-37B                          8005B     0B        CYCLE NF TIMES
          15000000B                     0B        WRITE EOF ON 15
          16000000B                     0B        WRITE EOF ON 16
                                                                      +

8010B                                   0B        LOAD + EXECUTE
          8200B                         0B        PARTITION CORE
          -3000000B                     0B        REW 3
          -10000000B                    0B        REW 10 (STRESSES)
          -14000000B                    0B        REW 14 (PARAM)
          -15000000B                    0B        REW 15 (REAL-CPSD)
          -16000000B                    0B        REW 16 (IMAG-CPSD)
14000000B           8000B               0B        READ PARAM
          10001000B                     0B        SKIP 1 EOF ON 10
10000000B           1B                  0B        READ STRESS
15000000B           2B                  0B        READ REAL CPSD
1B        2B        3B                  6B        S*CPSD-REAL
3B        1B        4B                  7B        S*CPSD*S TRANP
4B                  3000000B            0B        STORE ON TAPE 3
16000000B           2B                  0B        READ IMAG CPSD
1B        2B        3B                  6B        S*CPSD IMAG
3B        1B        4B                  7B        S*CPSD*S TRANP
4B                  3000000B            0B        STORE ON TAPE 3
-8B                           8005B     0B        CYCLE NF TIMES
          -15000000B                    0B        REW 15 REAL CPSD
          -16000000B                    0B        REW 16 IMAG CPSD
-12B                          8007B     0B        CYCLE STRESSES
          3000000B                      0B        WRITE EOF ON TAPE 3
                                                                      +


8200B                                   0B        LOAD + EXECUTE
```

```
               8500B                                        0B        PARTITION CORE
               -4000000B                                    0B        REW 4 (CONSTANTS)
               -12000000B                                   0B        REW 12 (OUTPUT)
               -14000000B                                   0B        REW 14 (PARAM)
               -15000000B                                   0B        REW 15 (REAL-CPSD)
               -16000000B                                   0B        REW 16 (IMAG-CPSD)
14000000B                     8000B                         0B        READ PARAM
4000000B                      8010B                         0B        READ CONSTANTS
1014B                                        8004B          27B
8500B                                                       29B       NULL MATRIX
8501B                                        8003B          27B       ADD ROW DIM
8502B                                        8003B          27B       ADD COL DIM
8013B                         8199B                         27B
-1011B                                       1B             27B       READY NEXT SCL
15000000B                     2B                            0B        READ A MATRIX
8199B          2B             2B                            5B        A*SCL
2B             1B             1B                            1B        SUM
-5B                                          8005B          0B        CYCLE FREQ
1B                            12000000B                     0B        STORE JD
-1071B                                       8005B          33B       SET LOC AGAIN
-1061B         -1B                           1000000B       27B       SET TO TAPE 16
-13B                                         2B             0B        CYCLE BACK FOR IM
               12000000B                                    0B        WRITE EOF ON 12
                                                                                             +

8010B                                                       0B        LOAD + EXECUTE
               8200B                                        0B        PARTITION CORE
               -3000000B                                    0B        REW 3
               -12000000B                                   0B        REW 12(JD)
               -14000000B                                   0B        REW 14(PARAM)
14000000B                     8000B                         0B        READ PARAM
               -10000000B                                   0B        REW 10 (STRESSES)
12000000B                     1B                            0B        READ JD
               10001000B                                    0B        SKIP 1 EOF ON 10
10000000B                     2B                            0B        READ STRESS
2B             1B             3B                            6B        S*JD
3B             2B             4B                            7B        S*JD*S TRANP
4B                            3000000B                      0B        STORE ON TAPE 3
-4B                                          8007B          0B        CYCLE
-8B                                          2B             0B        CYCLE REAL.IMAG
               3000000B                                     0B        WRITE EOF ON TAPE 3
                                                                                             +

8010B                                                       0B        LOAD + EXECUTE
               8200B                                        0B        PARTITION CORE
               -3000000B                                    0B        REW 3
               -12000000B                                   0B        REW 12 (JD)
               -14000000B                                   0B        REW 14 (PARAM)
14000000B                     8000B                         0B        TEAD PARAM
               -10000000B                                   0B        REW 10 (STRESSES)
12000000B                     1B                            0B        READ JD
               10001000B                                    0B        SKIP 1 EOF ON 10
10000000B                     2B                            0B        READ STRESS
2B             1B             3B                            6B        S*JD
3B             2B             4B                            7B        S*JD*S TRANP
4B                            3000000B                      0B        STORE ON TAPE 3
-4B                                          8007B          0B        CYCLE
-8B                                          2B             0B        CYCLE REAL.IMAG
               3000000B                                     0B        WRITE EOF ON TAPE 3
                                                                                             +

$EOF
```

REFERENCES

1. L. D. Jacobs and D. R. Lagerquist, Finite-Element Analysis of Complex Panel Response to Random Loads, AFFDL-TR-68-44, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio (in press)
2. L. D. Jacobs and D. R. Lagerquist, A Finite Element Analysis of Simple Panel Response to Turbulent Boundary Layers, AFFDL-TR-67-81, Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio, December 1967
3. D. R. Lagerquist and L. D. Jacobs, Random-Vibration Analysis System for Complex Structures, AFFDL-TR-68-43, Part I, "Engineering User's Guide," Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio (in press)
4. J. H. Wilkinson, The Algebraic Eigenvalue Problem, Oxford University Press, 1965

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
The Boeing Company, Commercial Airplane Division
P.O. Box 707, Renton, Washington 98005

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
Random - Vibration Analysis System for Complex Structures
Part II--Computer Program Description

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final Report July 1966—December 1967

5. AUTHOR(S) *(First name, middle initial, last name)*
K. Tsurusaki and F.S. Wallace

6. REPORT DATE
January 1969

7a. TOTAL NO. OF PAGES
482

7b. NO. OF REFS
4

8a. CONTRACT OR GRANT NO.
AF 33 (615)-5155

b. PROJECT NO.
1471

c. TASK NO.
147101

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
D6-23145, Part II

9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
AFFDL-TR-68-43, Part II

10. DISTRIBUTION STATEMENT
~~Distribution limited to U. S. Government agencies only; test and evaluation statement applied~~ December 197
~~Other requests for this document must be referred to AF Flight Dynamics Laboratory (FY), Wright-Patterson AFB, Ohio 45433~~

Approved for public release; distribution unlimited
~~ntrols, and each transmittal to foreign~~
~~le only with prior approval of the Air Force~~
~~son AFB, Ohio 45433.~~

12. SPONSORING MILITARY ACTIVITY
Air Force Flight Dynamics Laboratory (FDD)
Wright-Patterson AFB, Ohio 45433

13. ABSTRACT

A programming description is presented for a computer program developed to aid in the design of sonic-fatigue-resistant aircraft structure. The computer program is written in FORTRAN IV and MAP for the IBM 7094 Mod. II. The program employs matrix structural analysis methods to calculate statistical measurements of response (deflection and stress) for complex structure subjected to pressure loads random in both time and space. The program is organized into two phases, each performed separately. The phases are further organized in modular form for ease of maintenance and/or modification.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Computer Program Description						
Digital Computer Program						
Matrix Structural Analysis Methods						
Finite-Element Structural Methods						
Random-Vibration Analysis System						
Acoustic Vibration Analysis System						
Structural Vibration Analysis System						
Stiffness Matrix						
Eigen values						
Random Fluctuating Pressure Loads						